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Remote Usability Testing with Live Video Streaming

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ABSTRACT OF THE MASTER'S THESIS

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Being able to observe usability tests remotely would increase the flexibility of the usability testing process and decrease the expenses of traveling to the test site. This thesis assesses how streaming video over the Internet would fit the usability testing process, what kinds of solutions are available and how they perform. The usability testing process is a part of product development and the human-centered design process.

In the beginning, the criteria for a remote observation tool for usability testing were defined. Four different solutions were evaluated by their characteristics and features which were also tested in a real usability test environment.

The remote observation tool must guarantee reliable, secure and uninterrupted live video transmission and playback. Unlike in entertainment, the tool is not required to offer a high quality media experience. The tool should also support at least the basic usability testing setups. There is no ultimate generic choice for the tool but there are suitable candidates for different needs and situations.

Keywords: usability, testing, observation, streaming, video, live

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Käytettävyystestien etähavainnointi lisäisi käytettävyystestausprosessin joustavuutta ja vähentäisi testipaikalle matkustamiseen liittyviä kuluja. Tässä diplomityössä arvioidaan kuinka suoratoistovideo Internetin välityksellä sopii käytettävyystestausprosessiin, minkälaisia ratkaisuja tähän on tarjolla ja kuinka nämä ratkaisut suoriutuvat. Käytettävyystestausprosessi on osa tuotekehitystä ja ihmiskeskeistä suunnitteluprosessia.

Aluksi etähavainnointityökalulle määritettiin vaatimukset. Neljä eri ratkaisua arvioitiin ominaispiirteidensä ja ominaisuuksiensa kautta, sekä testattiin aidossa käytettävyystestiympäristössä.

Etähavainnointityökalun tulee taata luotettava, turvallinen ja katkeamaton suora videoyhteys ja toisto. Toisin kuten viihteessä, työkalun ei tarvitse tarjota korkealuokkaista mediakokemusta. Työkalun tulisi myös tukea vähintään tavanomaisimpia käytettävyystestilaitekokoonpanoja. Työkalulle ei ole ylivoimaisesti parasta yleisluontoista ratkaisua, mutta erilaisille tarpeille ja tilanteille on tarjolla varteenotettavia kandidaatteja.

Avainsanat: käytettävyys, testaus, havainnointi, suoratoisto, video, suora

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Otaniemi, 11.4.2011

Pauli Rinne

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Abbreviations

CDN Content Delivery Network
A network that guarantees the delivery of content (e.g. media).

ETF Etnoteam Finland
A user experience consultancy firm in Finland.

HD High Definition
A standard for high quality video.

HTTP Hypertext Transfer Protocol
A protocol for transferring data over the Internet.

IM Instant Messaging
A way of communication by having a live text-based chat over a network.

IP Internet Protocol
A protocol used in the Internet data traffic.

ISO International Organization for Standardization
An organization providing international standards.

PD Product development
The process of transforming ideas into products.

PiP Picture-in-Picture
Two video feeds as one in a way where a smaller one is on top of the other.

SaaS Software-as-a-Service
Remotely hosted ready-to-use software, service instead of ownership.

UI User Interface
The interface of a product that the user interacts with.

UX User Experience
The comprehensive experience resulting from the use of a product.

1 Introduction

Usability testing can be a heavy and relatively resource-demanding tool for the usability evaluation of various products. Yet it remains an extremely powerful method for introducing the voice and feedback of the end users into product development. The current practice of observing usability tests favors being on-site while the tests are being conducted. Remote observation of usability tests would lower the costs of the evaluation method – especially in the case of international usability testing - and introduce more flexibility into the process. Furthermore, the remote observation would enable efficient utilization of distributed design teams. This thesis explores how live streaming video could be harnessed to support remote observation of usability tests.

Usability as a concept has been gaining attention in the past years. Making usable products, especially in case of websites and electronic devices with user interfaces, is important because products with better user experience perform better in the market compared to similar products (Klein Research, 2006). Since for instance websites and mobile devices are rather mature innovations as products and the competition is thus tough, even surviving in these markets requires also competitive usability and user experience.

Usability testing is a method where the targeted end users of a product try out how they succeed in their goals by using the features of the product. There are numerous different methods and tools for the evaluation of usability, but in this context *usability testing* means the method of introducing a product or a prototype of a product to the end users and collecting feedback from them while they are using the product in a pre-defined environment. The process involves the observation of the test events and the collection of feedback directly from the end-users. These kinds of arrangements are far from cost-effective, since there are also usability methods available that do not require the presence of the end users (Jeffries & Desurvire, 1992).

However, usability testing is an essential depth-giving part in user-oriented product development where the goal is to develop an outstanding user experience (Bey, 2010). Without testing the product and the user interface designs with the actual targeted end users there is a great risk of having critical flaws in the product.

If usability testing could be observed remotely the costs would be significantly lower because the observing parties of the tests would not have to travel to the test site. This is especially important when long-distance traveling is involved, e.g., when product development and target markets are in different countries. Furthermore, the actual test sessions could be conducted almost anywhere in the world where there is sufficient infrastructure for the required communications. Both of these improvements would also increase the flexibility of the process of usability testing simply because the observing parties' geographical location would lose its importance.

Live video streaming over the Internet is the current state of the art technology to observe events remotely as they happen. For example, the much discussed giant in the smartphone business, Apple, streams all of its invitational promotional events live on their website for everyone. Furthermore, services like Youtube and Vimeo have introduced the concept of streaming video, though not live streaming, for the world. The number of registered users of the Youtube service alone is approximately 50 million (NumberOf.net, 2010).

Research Questions and Objectives

The research questions of the Master's thesis are as follows:

- What are the requirements for a solution for observing usability tests remotely using live streaming video technology?
- What are the currently available solutions and how do they fulfill these requirements?

The objectives related to the research questions are:

- To define how remotely observing usability tests with live streaming video fits the overall process of usability testing. In other words, to define the pros and cons in the overall remote live streaming approach.
- To define the requirements for remote observation of usability testing and to define how these requirements can be achieved with the live video streaming technology.
- To study and compare different existing live streaming solutions in practice and to find out if a proper solution already exists.

- To study if the live streaming technology enables any additional benefits in usability testing and also to discover if there are any significant drawbacks (that are not present in case of on-site observation).

Scope

The scope and focus of the thesis concentrate on the task of observing usability tests. Thus the goals from the usability point of view are highlighted and other perspectives are taken into account only minimally. These other perspectives are, for example, the broader perspectives of the organization developing the product or the organization responsible for the usability evaluation. The remote observation solution is considered only as a mere tool for observing a live remote event - a usability test event. The desirable characteristics of the solution are considered only from the observing parties' viewpoint and the characteristics of the solution are to support the tasks and goals of the parties observing such events. Thus, such a solution is a remote observation tool for all kinds of parties conducting usability tests.

The usability tests themselves are in this context broadly defined. They may be almost any kind of arrangements where almost any kind of product is being tested in almost any kind of environment. As long as an audiovisual setup and the required communication infrastructure are present, there are no limitations to the usability test setup or other arrangements. And as stated previously, the end-users are using a product or a prototype in some way. The broad scope concerning usability tests affects the results directly; the streaming solution would be quite different if only meant for, e.g., website usability testing.

There are solutions for conducting usability testing completely remotely. It should be stressed that this thesis is not about these kinds of applications. The keywords *remote usability testing* usually lead to website or screen capture oriented applications. These applications are limited to computer-operated products and the main idea of the applications is that the whole test is remote. That is, the end user is performing the test alone with instructions given remotely. This research concerns a universal tool for all kinds of usability tests. Furthermore, the thesis concentrates on such tests where the test personnel are operating on-site in a traditional way – only the observers' location is remote. In other words, usability test sessions are conducted as they would be without the remote observation solution but with an option to observe the events remotely.

The thesis covers an initial assessment of two different domains combined as one new combination of means and tasks. The domains are state-of-the-art video streaming and modern usability testing. The thesis discusses how the rather disruptive yet already mature streaming technology could be combined with usability testing in a way that would support the practice of usability testing in terms of goals and processes. The security of the streaming technology is also assessed in the thesis as an on/off-feature. What is said to be secure and what is actually secure is not in the scope of this thesis. Moreover, specific technical specifications related to the streaming technology are in the scope of this thesis.

Overall Structure of the Thesis

The thesis is divided into five main parts. First, the necessary and relevant background information is introduced in a top-down manner. The environment around usability tests is discussed from overall product development all the way to the specific task of observing usability tests. The background information is essential because without understanding the origins and reasons of the goals in observing usability tests it is easy to get lost in the details. Second, the process used to conduct the research related to the thesis is explained. Third, the results are introduced. The results are divided into a) the characteristics of an optimal solution and b) the most promising and interesting current solutions and the evaluation of these solutions in terms of features on paper and actual performance in usability tests. For each solution, the performance-based evaluation is discussed first. After that, the overall evaluation of a solution is described as a combination of the performance-based evaluation and the characteristics of the solution in question. The solution-specific results are followed by a brief comparison of the solutions. Fourth and last, the conclusions are introduced and future studies are discussed.

2 Background

This chapter describes the essential and necessary background information for understanding the environment and conditions of usability testing and observing usability tests. The chapter discusses the underlying and surrounding processes in a top-down manner all the way from product development to the details in observing a usability test. An overview of the hierarchy and the whole set of processes is presented first. After that, the blocks presented in the overview are discussed one by one.

Usability testing should be aligned to the larger strategic goals of product development. Forgetting such guidelines and principles can be strategically fatal. Even though a usability test would seem successful it might be the case that it is a total failure if it does not support the goals and processes of the larger whole that the test is part of. With regard to this thesis, thorough background information will assure that the research does not get lost in the details and will be valid for real life product development.

In the end of this chapter, the basics and relevant characteristics of video streaming technology are discussed. Understanding the limiting factors of the technology in question is essential to properly understand the domain of this thesis.

2.1 Overview of the Processes Related to Usability Testing

First an overview of the whole process and its hierarchy is provided in order to comprehend the following sections properly. The whole process in this case means all of the surroundings relevant to usability testing in terms of goals and processes.

The relevant entities around the observation of usability tests are depicted in Figure 2-1. The entities are different processes happening inside the outer entities. Thus the goals of an inner entity should match the goals of all the surrounding entities. The outmost entity in the context of this thesis is product development, which is discussed in Section 2.2. The entities in Figure 2-1 also reflect the structure of the background chapter of the thesis. The entities themselves are (starting from the outermost ring): product development (*the parent process for all the other processes involving any* *kind of development of a product*), human-centered design process (*the philosophy and process to highlight the human factors and usability of a product in product development*), usability evaluation (*a part of human-centered design process for assessing the usability of a product and the observation of usability tests*) and is following the events of usability tests and making findings.

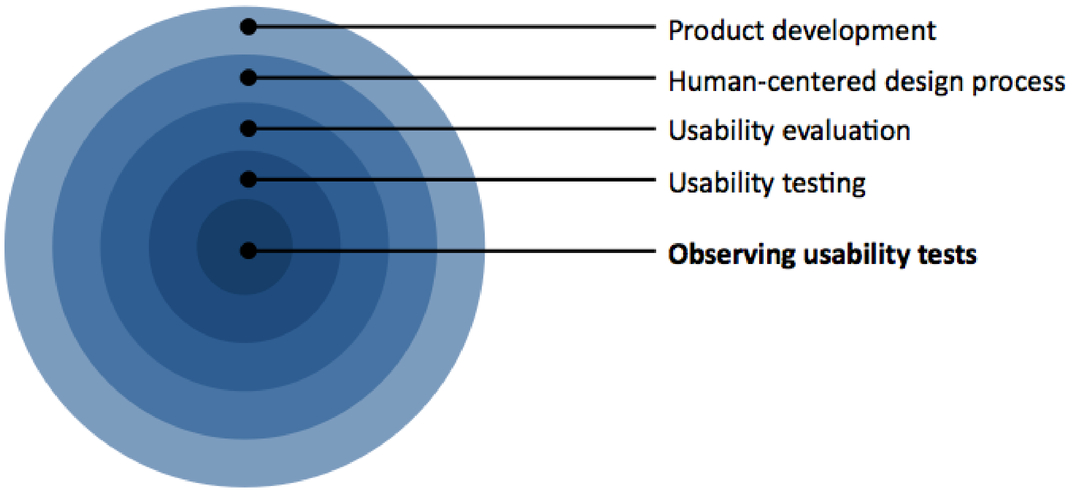

Figure 2-1: The processes surrounding the observation of usability tests

Unquestionably there are far more different processes and goals happening around usability testing but only the directly relevant processes are discussed in this thesis. For example, an extremely important corporate function like marketing is at least as essential as usability testing for the success of a particular product but is not directly relevant to what is to be achieved in usability testing.

2.2 Product Development

This section discusses the outermost entity described in Section 2.1, that is, product development. It is thus also the first entity of the top-down approach used in describing the background information relevant to observing usability tests. Product development is the largest underlying relevant process and characterizes all of the lower-level processes, for example, in terms of goals. The goals of product development described as the characteristics of successful product development, a generic product development process and the main challenges in the process are discussed.

The characteristics of successful product development are (Ulrich & Eppinger, 2008, p. 2):

- *High product quality*: How the product responds to customer needs, how reliable and robust it is.

- *Low product cost*: The manufacturing cost should be low to keep the price low and thus obtain profit.

- *Short development time*: How responsive the party developing the product is to the competitive forces and to technological developments. Also how quickly the revenues can be received from the development efforts.

- *Low development cost*: The investments in development are important in the same way as the product costs.

These four characteristics describe very holistic criteria for desirable product development. Making as good products as possible with as low costs as possible may feel intuitive but usability testing affects these all in ways that are not self-explanatory. For instance: Usability testing may improve the product quality and the product cost should always be kept in mind when evaluating improvement ideas. Early testing can also prevent unnecessary loss of time. On the other hand, early testing is also a concrete addition to the development costs.

A generic example of the product development process, in which the characteristics of successful development are realized, is depicted in Figure 2-2. As can be observed from the figure, the process is divided into sequential phases of planning, concept development, system-level design, detail design, testing and refinement and production ramp-up. It is important to be aware of the current phase of the product and how the phase relates to the whole process.

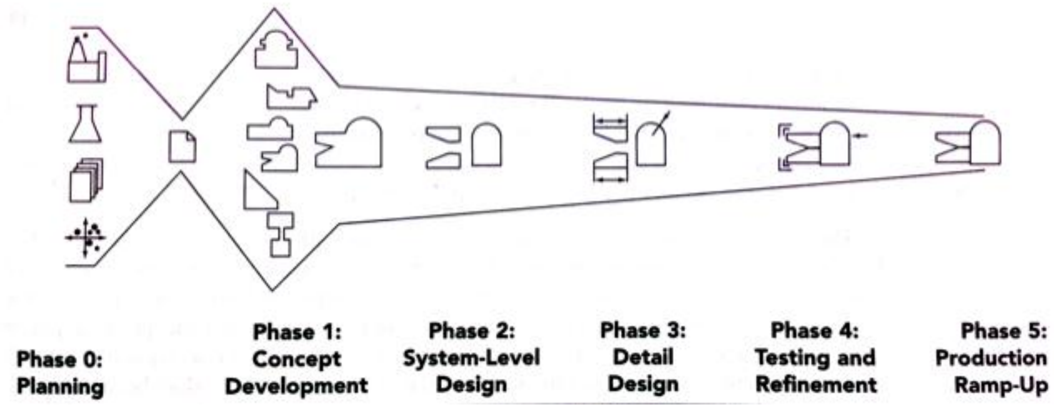

Figure 2-2: The generic product development process (Ulrich & Eppinger, 2008, p. 14)

Briefly explained, the generic model of the product development process is about having lots of different ideas in the phase of planning, narrowing them down to several concepts in the concept development phase, developing the most promising concept further in the system-level and detail design phases and starting the production of the product after testing and refining it. As can be observed, the ability to change the specifications of the product is greatly diminished when approaching the final phase. This relates to the goals and level of feedback of usability testing dramatically.

Even though there is a phase called testing and refinement, it does not mean that usability could not be evaluated in the other phases. For example, the ideas and concepts are also evaluated when narrowing them down and there is no reason why also usability could not be part of the evaluation. Usability tests may be very different in nature during the different phases of the product development process.

In addition to recognizing the phase related factor: different kinds of product development challenges also restrain the domain of usability testing. The most relevant PD-level (product development level) challenges from the challenges listed by Ulrich & Eppinger (2008, p. 6) are:

- *Trade-offs*: Making one part better weakens another.
- *Dynamics*: Constantly changing environment makes decision making difficult.
- *Time pressure*: Decision making is usually made quickly and without complete information.

- *Economics*: The resulting products have to be appealing and reasonably priced to gain sufficient return on investments.

All of these challenges are related to the goals of usability testing since the purpose of usability testing is to validate and modify the product.

2.3 Human-centered Design Process

In this section the concept of human-centered design is discussed. Before going through the process itself, the equivocal concept of usability will be defined since it is the main goal of the process and might be hard to comprehend. The human-centered design process may be applied to product development if the developing party sees the usability and human-orientation of the product important. Product development can also focus on, for example, cost efficiency, which naturally does not exclude usability testing.

In this thesis it is assumed that the human-centered design process is part of the whole process where the usability testing is implemented. Obviously, usability can be tested without the human-centered design process but the characteristics of the design process are taken into account in addition to the most direct characteristics of the usability testing process in the context of this thesis.

2.3.1 Usability

Usability is a concept of many different definitions, like art or science. Two different popular definitions of usability will be introduced individually and the definition of the concept is concluded from the examples put together.

Perhaps the most wide-spread definition of usability is Jacob Nielsen’s definition. He perceives usability as five qualitative characteristics (Nielsen, 1993, p. 26):

- *Learnability*: How easy is it for users to accomplish basic tasks the first time they encounter the design?

- *Efficiency*: Once users have learned the design, how quickly can they perform tasks?

- *Memorability*: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
- *Errors*: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- *Satisfaction*: How pleasant is it to use the design?

The International Organization for Standardization (ISO) has a slightly different definition of usability in its standard ISO 9241-11. ISO defines usability in the following manner: *"Extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."*(ISO, 1998)

There are of course many other definitions of usability but the essence of usability can be concluded from the two examples. Usability is thus a qualitative and measurable entity that expresses the whole of different qualitative measures of a product's user interface. The definition of usability thus depends on the approach. Thus, usability has the same general definition but can be perceived differently, for instance, in case of mobile devices and websites.

2.3.2 The Human-centered Design Process

This section describes the process to bring usability into the product development process. As in the case of usability, there are numerous ways to implement the usability-oriented design process. The standardized ISO (International Organization for Standardization) way is introduced accompanied by another approach by a user experience consultancy firm.

The standardized approach to the human-centered design process of ISO 9241-210 is depicted in Figure 2-3. The principles of the process are (ISO, 2010):

- The design is based upon an explicit understanding of users, tasks and environments.
- Users are involved throughout design and development.
- The design is driven and refined by user-centered evaluation.

- The process is iterative.
- The design addresses the whole user experience.
- The design team includes multidisciplinary skills and perspectives.

The essence of the process is iterating for a proper solution from the users' perspective. After planning the process the specifications are made based on the context of use and the user requirements. The products or prototypes are developed from these user-oriented specifications. The output of the development efforts is then evaluated against the same requirements that were the basis for the development in the first place. If the development output matches the goals and specifications set by user requirements and the context of use the design is complete. If not, the process iterates around the previous phases as depicted in Figure 2-3.

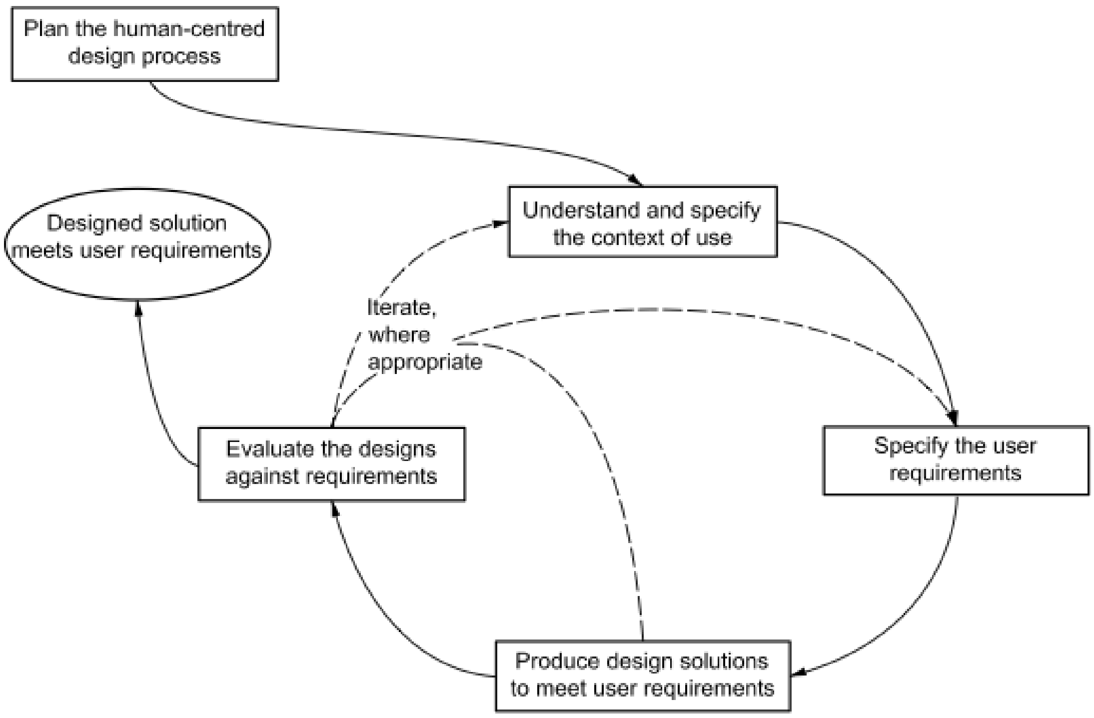

Figure 2-3: The human-centered design process (ISO, 2010)

Another view of the human-centered design process is illustrated in Figure 2-4. The approach is the general service offering of a Finnish user experience consultancy firm, Etnoteam Finland (ETF). The process of ETF is also iterative and consists of similar phases as the standardized ISO approach.

ETF defines the process as a loop of understanding, creation and evaluation. There is no beginning and no end compared to the ISO approach. Thus the human-centered design process can be introduced into product development in any phase. Furthermore, the human-centered design process does not necessarily have to be a complete loop. Instead, in practice it can also be a part of the process described in the ISO approach.

Figure 2-4: The Etnoteam Finland approach to the human-centered design process (Etnoteam Finland, 2010)

As can be observed from the two examples, the design process for human-orientation and usability is iterative and highlights the end-users who are directly involved in the process. Even though only two examples were presented, the literature on the subject, such as *Designing the User Interface* by Ben Shneiderman and *Designing interactive systems: people, activities, contexts, technologies* by David Benyon et al., confirms that these two principles are present when usability is one of the top priorities in the design process.

There may be many other goals, like user experience, in a process such as the ones described above. User experience is a broader concept similar to usability. User experience encompasses all aspects of the end-user's interaction with the company, its services, and its products (Norman Nielsen Group, 2007). However the goals are defined, the overall goal of such a process is still to create products that are human-friendly, easy to use and appealing to the targeted end-users. It is up to the party responsible for the human-centered design process to decide whether they wish to focus on the core usability or the broader user experience of the product.

2.4 Usability Evaluation

This section discusses the evaluation phase of the human-centered design process described in the previous section. The purpose of the phase and its relationships with the other phases are discussed and different types of methods and tools are briefly introduced. In the context of this thesis, the evaluation phase is naturally the most important phase of the human-centered design process.

As stated in the previous section, the evaluation phase takes place after a phase involving design. Thus, its main function is to evaluate the realized design(s) against the human-centered goals that were defined in the beginning of the process, in an ideal case at least. According to the conclusions of the previous section, the evaluation results in a new iteration if the results of the evaluation are not satisfactory. In case the design is finished in terms of usability, perhaps after a few rounds of iteration, the role of the evaluation phase is to accept and freeze the current design.

The overall purpose of usability evaluation is not only to examine the surface features but also to find out if the product is fit for its purpose – anything from entertainment to order processing (Benyon, et al., 2005, p. 268). Thus the main goals of usability evaluation are not only to see if the product is easy to use but also to assess how the product performs as a whole in the hands of the end-users. Naturally the main goal can be defined as good usability – the concept defined in Section 2.3.1.

The detailed goals may vary. The test-specific goals depend greatly on the context of the test. Some examples of the detailed goals will be introduced to illustrate this since they are the ones behind usability test observation sessions also. For example, usability evaluation can focus on:

- The overall performance of the core functionalities.
- A part of the design.
- A part of the overall functionality.
- A certain sub-group of the end users.
- Interoperability with other devices.

- The performance of a product in a certain context.

There are various methods and tools available for usability evaluation. They are usually divided into two categories – expert evaluations and user-based evaluations, usually usability tests (Benyon, et al., 2005, p. 285; Shneiderman & Plaisant, 2010, p. 184; Usability.gov, 2009). The expert evaluations are various methods in which the evaluation is made by one or more usability experts. The user-based methods involve naturally the presence and participation of end-users themselves.

However, Dillon makes a little more fine-grained division of the methods. He divides the expert evaluations into expert-based and model-based methods. The model-based methods represent the formal methods. The expert-based methods are more informal assessments of the product. The relative advantages and disadvantages are summarized in Table 1. (Dillon, 2001)

Table 1: Relative advantages and disadvantages of usability evaluation methods (Dillon, 2001)

Usability methods	**Advantages**	**Disadvantages**
User-based	• Most realistic estimate of usability • Can give clear record of important problems	• Time consuming • Costly for large sample of users • Requires prototype to occur
Expert-based	• Cheap • Fast	• Expert-variability unduly affects outcome • May overestimate true number of problems
Model-based	• Provides rigorous estimate of usability criterion • Can be performed on	• Measures only one component of usability • Limited task applicability

	interface specification	

The method to be used depends on the context of the development and the resources available. Also the overall plan for evaluation including the methods and tools to be used is far from generic. According to the aggregation of the information of multiple sources (as cited in Shneiderman and Plaisant, 2010, p. 150), the determinants for the evaluation plan (Nielsen, 1993; Dumas and Redish, 1999; Sharp, et al., 2007) include at least:

- Stage of design (early, middle, late).
- Novelty of the project (well defined versus exploratory).
- Number of expected users.
- Criticality of the interface (e.g. life-critical systems versus entertainment systems).
- Costs of the product and finances allocated for testing.
- Time available.
- Experience of the design and evaluation team (in terms of usability-related skills).

As can be observed from the list, there is no right or wrong way to implement usability testing in terms of different tools and methods. Refining the budget or changing the amount of time available for the usability evaluation project would already be critical to the realization of the optimal implementation. An expert evaluation could be a good way to assess the usability of a product in an early phase when there is no valid prototype to be presented to the end users whereas usability testing would probably fit rather mature stages of the development process when there are prototypes available. The method itself already characterizes the nature of the results and should be chosen according to the desired findings. For example, expert-based evaluations produce findings relevant for the experts. Those findings might differ from the findings of a usability test.

Whatever the methods are, usability evaluation should be carried out throughout the entire development process (Stone, et al., 2005, p. 22) and it should be introduced into the process as early as possible because making changes gets harder and more expensive as the design matures (Usability.gov, 2009) – there is simply more and more sunk costs and work to be done afresh.

2.5 Usability Testing

In this section the method of usability testing is described. The general process and goals of usability testing are discussed and the specific phases are explained. Also several examples of usability test setups are presented. Familiarizing oneself with the method of usability testing is essential before considering the requirements for the remote observation of usability tests.

Usability testing (or user testing) is one of the tools and methods to perform usability evaluation. It is a rather heavy, resource-demanding and expensive method involving the live interactive participation of the end users. Thus it should be used when the design is mature enough to have a prototype that the end users can really interact with. It is a very powerful tool to introduce the voice of the end users into the product development process and can also be used early in the product development process with, for instance, paper prototypes (Etnoteam Finland, 2010).

There are many approaches to usability testing. The traditional approach is to have one user at a time performing pre-defined tasks with a product and thinking aloud in a controlled environment (Riihiaho, 2011). Other approaches involve changes to the number of simultaneously participating users, the interaction with the product, or the environment (Riihiaho, 2011). The environment, or the context, can be also thought as the length of the study.

The goals are derived from the goals of usability evaluation (see Section 2.4). The method-specific goals can be defined as (Dumas & Redish, 1999, p. 23):

1. The primary goal is to improve the usability of a product. For each test, there are more specific goals and concerns that are articulated when planning the test.

2. The participants represent real users.

3. The participants do real tasks.

4. The evaluator observes and records what participants do and say.

5. The evaluator analyzes the data, diagnoses the real problems, and recommends changes to fix those problems.

The general process of usability testing can be seen as three sequential phases: planning, conducting and analyzing (Sinkkonen, 2002; Usability.gov, 2009). There is, of course, a more fine-grained structure that depends on the context but the three-phase generic model is sufficient to understand the overall process of a usability test project.

The planning is about documenting the test-related specifications to ensure that the correct and desired results are captured. A usability test plan includes the definitions of the scope, the purpose, the schedule and location, the sessions, the equipment, the participants, the scenarios, the metrics and roles of the participants (Usability.gov, 2009). In other words, it includes all of the practicalities concerning the tests.

Conducting the tests is about putting the plan into motion. The test participants have to be recruited before the actual test sessions. Usually a pilot test is held before the actual test sessions to allow changes to the plan. The test sessions are usually moderated and observed. The participants, the end-users, are taken through the planned test and the desired data is gathered by observing the test sessions. (Usability.gov, 2009)

The analysis transforms the test sessions to the results defined in the plan. The activities during the analysis phase depend greatly on the usability test plan. The results are obtained from the data gathered from the test sessions. The data can be quantitative and/or qualitative and the results should have a scale of importance (Usability.gov, 2009). The results concentrate on the problems rather than the parts that work well since the general goal is to improve the tested product.

The setups for usability tests can be very different depending on the product and its intended context of use. As stated previously, usability testing should assess how a product can be used as it is intended to be used. Thus the test arrangements should be as close to the natural environment of use as possible in order to obtain realistic results. Three different examples of usability test setups will be introduced to illustrate the varying conditions of usability test settings. The remote observation tool should be able to function in these settings.

Example 1 - A laboratory setup:

The first example represents the classical setup and arrangements of a usability test. The schematic of the setup is depicted in Figure 2-5. The example consists of various cameras, a separate observation room with a one-way glass and the actual testing room. In addition to the elements in the figure, there could be other arrangements and equipment present, such as interpretation arrangements, eye tracking equipment or additional microphones. The tested product in the laboratory setup could be anything from software to coffee makers. Nevertheless, in order to have an environment that is close to the real one, the laboratory setups work best with products intended to be used in an indoor room.

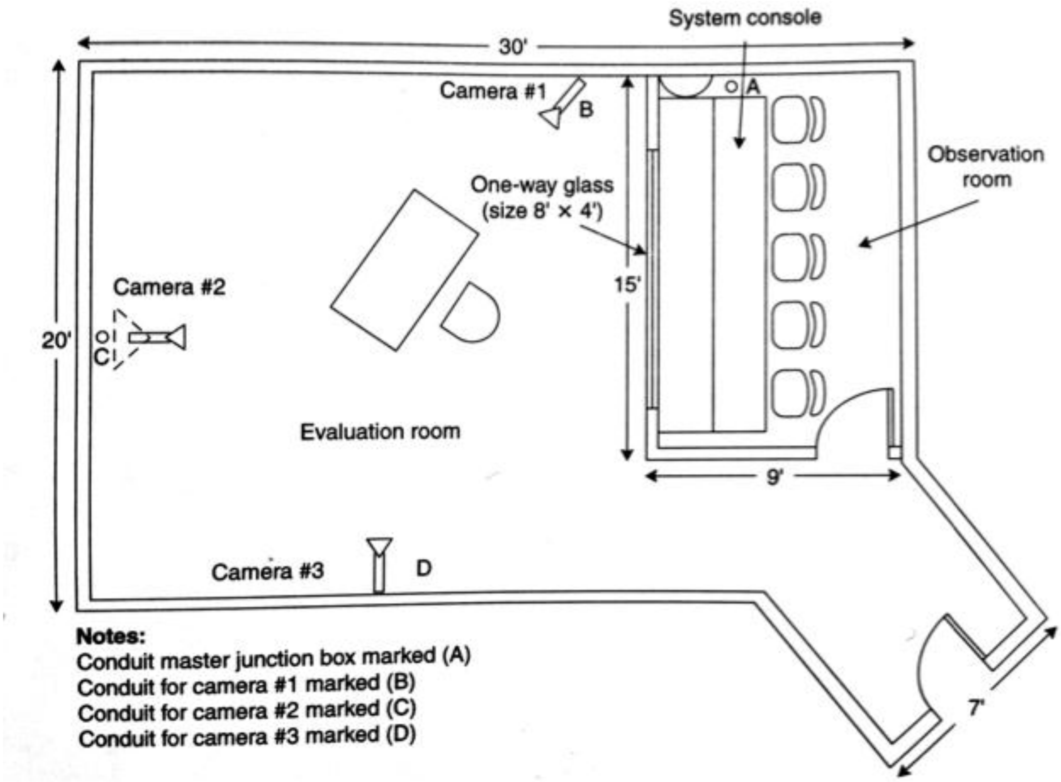

Figure 2-5: A usability test setup in a lab (Barnum, 2002, p. 14)

Example 2 – A field setup in a natural environment:

The second example is about a usability test happening in the natural environment of the product. Figure 2-6 illustrates a setting where a car navigator is being tested in its natural environment – in a car. The example represents all of the setups in which the product cannot be properly used in a laboratory room. In these kinds of settings the test setup tends to be rather light, simple and mobile.

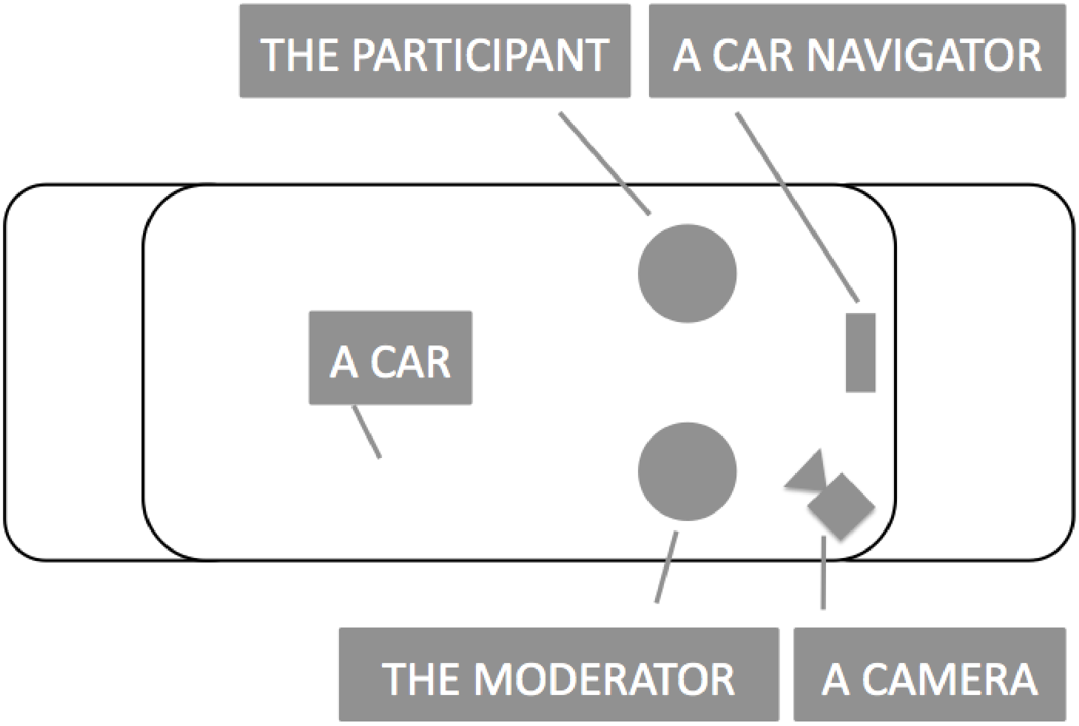

Figure 2-6: An example of a usability test setup in the field

Example 3 – A group setup:

The third example is a bit wilder and more unusual than the first two. Its purpose is to add a little variety and imagination into the set of examples. There are no laws in constructing a usability test setup – whatever works is allowed. Figure 2-7 shows an example where a group exercising gadget is being tested. Let's say that the gadget is for the social interaction happening during the group exercise sessions (e.g. motivating others). Thus the real use would require the interaction of a group. The overall performance of the group would not be interesting compared to the individuals' performances in using the gadget as a part of the group. All the individuals would have a recording device of their own and the test would be analyzed as multiple individual performances, not a single group performance. The test setup differs greatly from a laboratory setup even though it is held in an indoor room environment.

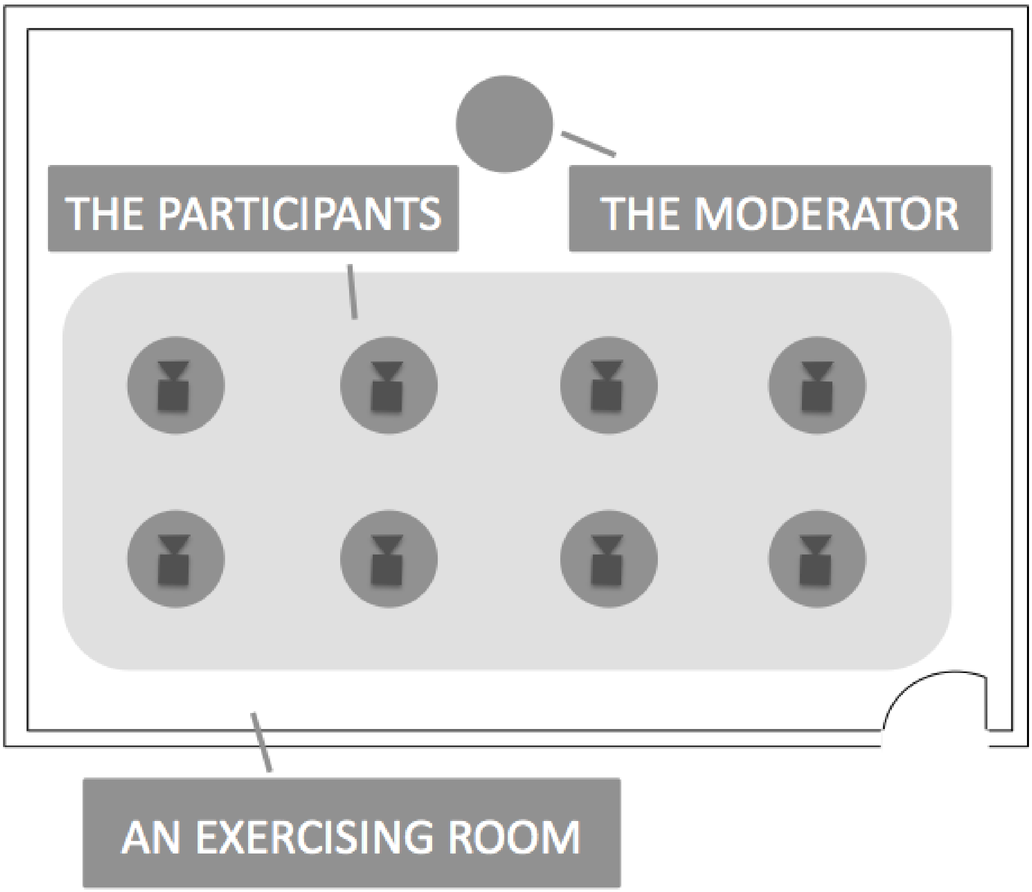

Figure 2-7: An example of a usability test setup with a group of participants

As can be observed from the examples, the variety of different usability tests and usability test setups is vast even though the traditional laboratory setups are probably the most common ones. However, even the laboratory setups can be quite different, starting from the different cameras available. The test equipment, including the possible remote observation solution, needs to match the requirements of the test setting.

2.6 Observing Usability Tests

This section introduces deeper knowledge of the task of observing usability tests. Observing usability tests is a part of conducting the tests and involves the collection of the test data in a more or less raw format. The subtasks and goals of the observation process are defined. These tasks and goals are the primary source of the requirements for a remote usability test observation solution.

Since the test participants are not always able to verbalize their perceptions, live onsite observation of usability tests increases the quality of the test data as the actions and reactions of the participants are noted (Benyon, et al., 2005, p. 283). Furthermore, as with any empirical method, the keys to success in a usability test are the observations and measurements that are made during the sessions (Dumas & Redish, 1999, p. 292). As also stated in the previous sections, the goal of usability testing is to improve the product. Improving the product is realized by improving the problems which were identified during testing. Thus, the observation is an essential task in achieving the strategic goals of the whole product development process.

The goals of the observation depend on the role of the observer. The observer can either be a usability expert involved in the analysis of the tests or a person of the development/design team. The general goals are the same, but a usability expert may be concerned more with the issues critical to the analysis since usability experts usually analyze the sessions, whereas a product developer may be more concerned with the overall performance of the product in the test sessions. Obviously, a product developer can also take the role of a usability expert. The analysis-critical issues are things like raw quantitative and qualitative data, task completion rates, errors, time periods spent on different tasks and user comments (Usability.gov, 2009). The observers of usability tests might also be the developers and designers who wish to see and learn how their product works with real end-users. These observers may not require as specific data from the process as the usability experts.

In addition to the live observation, the usability tests can be observed also from recordings. Instead of looking over the shoulders of the participants, it may be less obtrusive to videotape the tests and observe them through the lenses of cameras with the added benefits of replaying events and communicating the results as they really happened (Benyon, et al., 2005, p. 283). Since the both approaches have their pros and cons, the live onsite observation and the observation from a recording are more complementary than exclusive methods.

It has been argued though, that the live onsite observation of usability tests is a must (Spillers, 2009). The underlying reasons for the claim are that the direct experience with the users is the basis for the strength of usability testing, that the direct contact including the participant’s sighs and body language factor into a rich observation experience and that the full fidelity of their physical presence is a very powerful impression compared to watching a video later (Spillers, 2009). If a usability test is to be observed remotely, these kinds of factors should be taken into account.

The actual live observation can be done in many ways. Because of the various test setups (see Section 2.5), the actual ways to observe the test sessions are at least as varying. For example, the tests may be observed directly in the same space, they can be observed behind a one-way glass, or even by the live video feed of the cameras of the test setup. If the observer does not master the language used in the test sessions (e.g. English speaking observers in tests held in Finnish), there might be some kind of interpretation arrangements.

In conclusion, the observer needs to really comprehend what is happening while using a product, not just hear the words of the participant or see the steps the participant takes when trying to accomplish a task. It is the success of the observation what makes usability testing successful; interpreting the events in the test sessions in an incorrect way results in wrong conclusions.

2.7 Video Streaming Technology

In this last background section the video streaming technology is introduced and discussed. The basics of the technology are presented and the most essential issues on video streaming in the context of remote usability test observation are covered.

Streaming video, or any other media, is different from playing it locally. In the most basic definition, the only difference between streaming and traditionally playing the media locally is that in the case of streaming the media can be accessed and played before having the whole media locally (Topic, 2002, p. 10). The basic idea of streaming is presented in Figure 2-8. Video streaming can be also defined as the real-time delivery of video over a non-broadcast network (Lin, et al., 2001) from the viewpoint of technology.

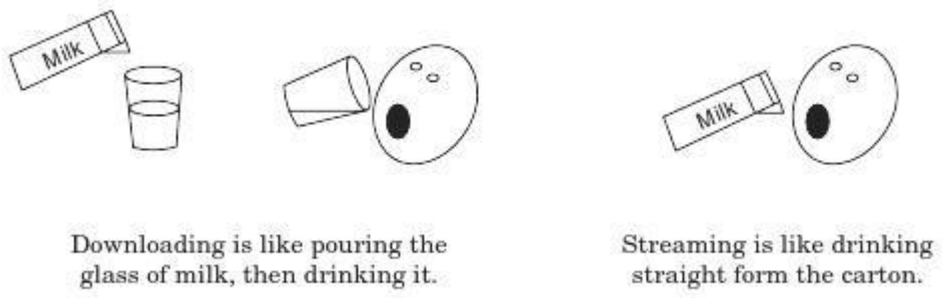

Figure 2-8: The basic idea of streaming media (Topic, 2002, p. 10)

Streaming media is either live or on-demand distribution of media on the Internet (Streamingmedia.com, 2011). Live video is being streamed as it happens and on-demand video is stored at a remote location and played when someone wishes to access the content. In the context of this thesis streaming video means transferring a video feed over the Internet by streaming. The focus is on the live streaming of video.

The architecture of streaming video over the Internet is depicted in Figure 2-9. The raw video and audio in the case of usability tests would be the video and audio sources of the test setups. The video is transported to the receiver, the observer, in a compressed format over the Internet through a streaming server. The client decodes the compressed video and audio and plays them synchronized.

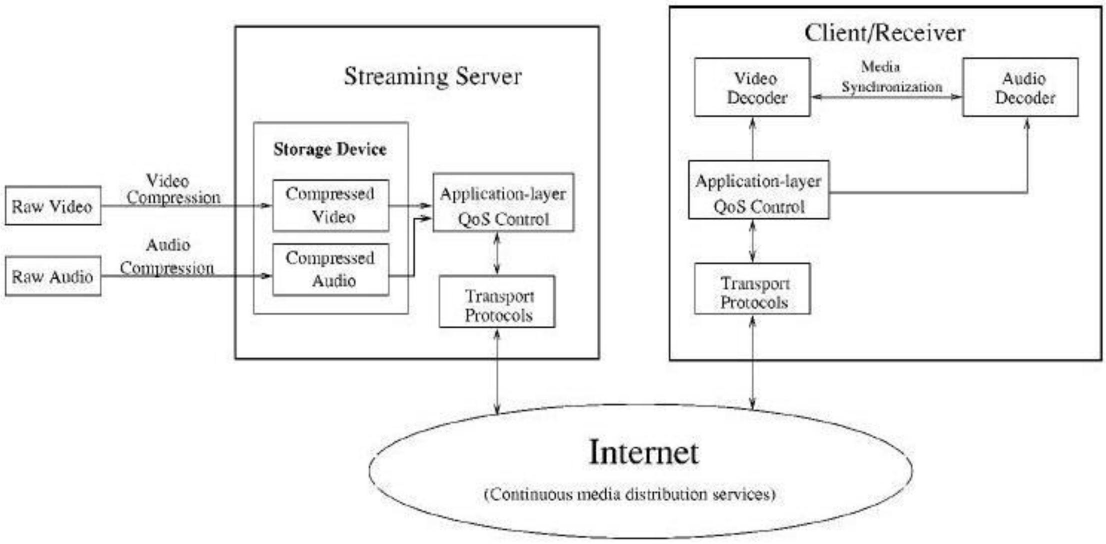

Figure 2-9: Architecture for video streaming (Wu, et al., 2001)

There are many issues and research areas under the topic of streaming video. The main issues concerning this thesis are the compression of the video, the required bandwidth for the streaming, the concept of buffering the stream, adaptive bitrate technology, content delivery networks and streaming video players. These issues affect the quality and realization of the remote observation solution.

Compression is a big subject, about which entire books are written (Topic, 2002, p. 59). This thesis will not provide an optimal compression solution. Instead, the concept of compression is discussed and the desirable characteristics of compression will be explained.

The captured raw video must be compressed to achieve efficiency and it is essential in streaming video (Topic, 2002, pp. 59-60; Wu, et al., 2001). The basic concept of compression is to make use of the available bandwidth as efficiently as possible (Topic, 2002, pp. 59-60). The generic process of compression is depicted in Figure 2-10. Simply put, the compression makes the video smaller by exploiting order and patterns (Topic, 2002, p. 60). In other words, *“video compression algorithms ("codecs") manipulate video signals to dramatically reduce the storage and bandwidth required while maximizing perceived video quality”* (Berkeley Design Technology, Inc., 2006). The compression can be lossy or lossless – the decompressed copy may be “good-enough” or exactly the same as the original (Topic, 2002, pp. 60-61).

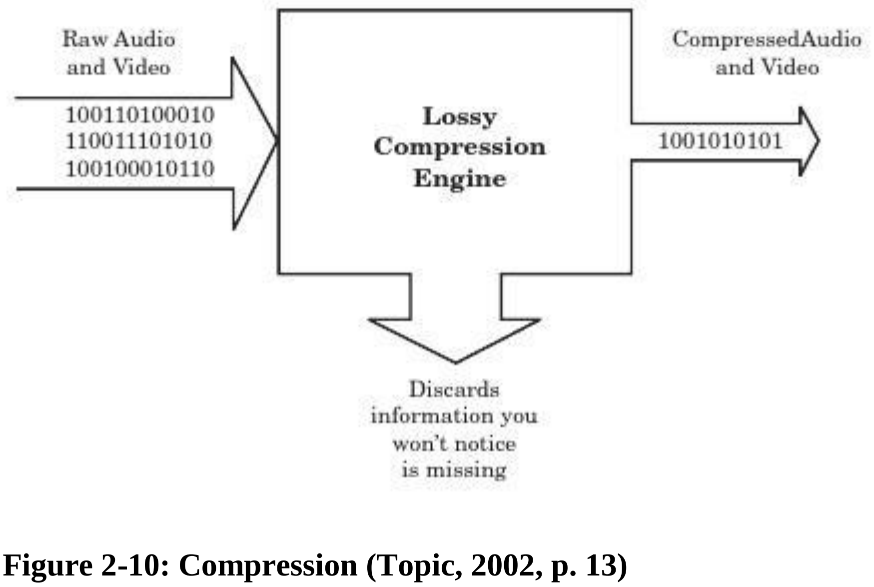

Figure 2-10: Compression (Topic, 2002, p. 13)

Selecting the proper codec depends on the desired quality, efficiency and the trade-off between them (Golston, 2004). Therefore the proper codec depends on the context and requirements of the use. The comparison of different compression methods is, however, a completely different topic, and is beyond the scope of this thesis.

Another essential issue is the bandwidth or the bitrate related to the video stream. Bandwidth describes a particular channel's capacity to deliver information and is measured by bits transferred per second (Topic, 2002, p. 65). In this case, the video stream requires a certain amount of capacity from the Internet connection. The required bandwidth thus depends on how many bits are required to be transferred over a period of time. Naturally, the better the quality of the video to be transferred the more bandwidth is required. On the other hand, the previously explained codecs decrease the required bandwidth.

Since the data needs to be transferred over the Internet, the video stream is not instantly played at the receiving party. The role of the buffer is illustrated in Figure 2-11. Shortly put, the received video is sequentially put in queue for playback. Thus there is a delay in the media at the receiving party. It can also be concluded that if the realized speed of the connection is slower than the playback speed, there is either a waiting period before the playback of the media or there are multiple buffering periods during the playback of the video.

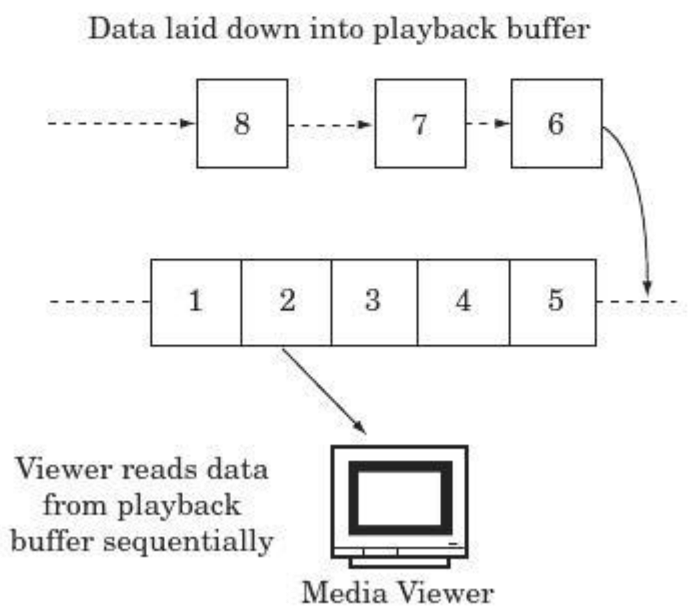

Figure 2-11: The role of the buffer in streaming media (Topic, 2002, p. 10)

To overcome problems related to these buffering issues, a recent innovation called adaptive bitrate has been adopted to the industry landscape – a technology that allows the stream to actually adapt the video experience to the quality of the network and the device's processing power (Philpott, 2011). The high-quality video is encoded into multiple versions of different quality and the copy with the proper quality is sent depending on the performance. The receiving party gets the video in 10 second chunks and can detect the quality of the network connection – the receiving party can switch to a higher or lower quality video segment every ten seconds if bandwidth conditions change (Philpott, 2011). The adaptive bitrate technologies, such as Smooth Streaming by Microsoft, are also streamed as regular HTTP traffic to avoid using special streaming servers, like in Figure 2-9. (Philpott, 2011)

Another solution to overcome problems in streaming video over the best effort network, the Internet, is to use a special content delivery network (CDN). A content delivery network is an overlay network which aims at efficiently delivering content over the Internet and improves the end user performance in terms of response times, delay, maximum bandwidth and worldwide connectivity (Chen, 2009). A popular CDN provider, Akamai, describe the benefits of CDNs (and advertise themselves) in the following way: *"Our global streaming platform extends your reach instantly, enables you to bypass traditional server and bandwidth limitations, and handle peak traffic conditions and large file sizes with ease—all without requiring additional infrastructure. Akamai Media Delivery enables the secure delivery of innovative rich media experiences—from video sharing to high-definition video online—quickly and flawlessly."* (Akamai, 2007) Akamai's description of a CDN is explained in Figure 2-12.

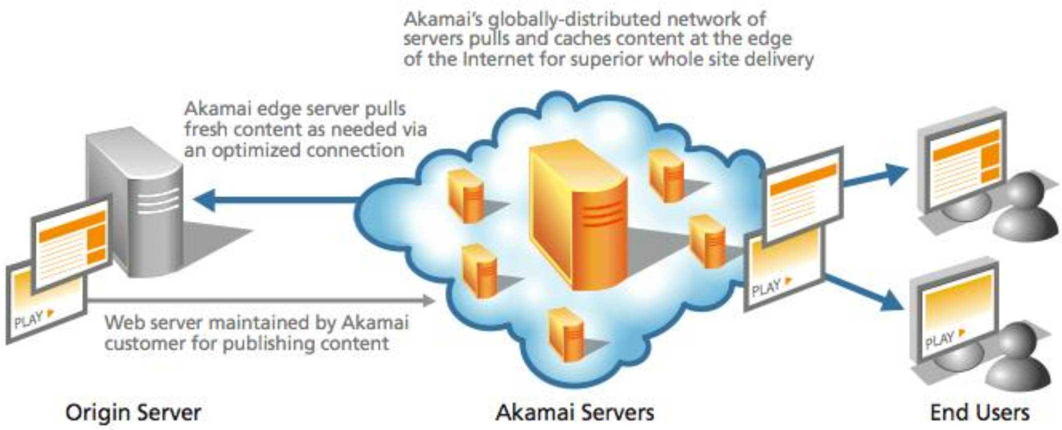

Figure 2-12: Content delivery network structure (Akamai, 2007)

The last streaming related issue to be covered is the role of different video players. A streaming media player is a piece of software that binds to the network interface that delivers the streaming media data and shows the video content (Philpott, 2011). The players can be a part of a website or separate applications on a computer. The features and characteristics of the player are essential in defining a live observation solution for usability tests.

The section of streaming technology will be concluded with some thoughts on the security of the technology. Since most unpublished products and prototypes are highly delicate, the streaming solution should provide sufficient security. For example, the next major thing coming from a major software company must not be accidentally revealed to the public because of poorly designed streaming tool. On the other hand, increasing security has also trade-offs. Security might stand in the way of performance, usability and also cost, time and effort (Freitag, 2009). In this thesis the security is more of an on/off –feature than a target of rigorous analysis. As mentioned in the introduction, what is considered to be secure and what is actually secure is not within the scope of this thesis.

3 Methods and Processes Used in the Research

This chapter describes the methods and processes used in the research of this thesis. This chapter describes how the answers to the research questions are obtained and with what kind of tools and methods. First, the overall process is described. Then the different phases are explained in more detail.

3.1 Overall Process

The overall research process is depicted in Figure 3-1. In the beginning the requirements for an optimal remote usability test observation tool were defined. After the different requirements were defined various different solutions and approaches were searched for and initially tested and evaluated. The results from the search was a set of the most promising solutions. These solutions were tested in a usability test environment and they were also analyzed more thoroughly in terms of features. The overall results were obtained from the test sessions of the most promising solutions and from the feature-based analysis of those solutions.

Figure 3-1: The overall process used in the research

3.2 Definition of the Requirements

The requirements for a remote observation solution for usability testing were defined based on two areas. First, the literature on the subject and the background desk research were naturally influencing the results heavily. Second, the writer’s years-long experience in UI design and usability evaluation is also behind the different relevant requirements that were defined.

The requirements were defined from the viewpoint of the usability test observer. Thus the perspective is rather non-technological. The main focus was on the goals and tasks of the observer; on the different things the observer needs to accomplish while observing the tests.

An important note on the observer's tasks is that the observer does not only have the role during the tests. The events right before and after the tests might be crucially important also in addition to the actual observation.

Nevertheless, the streaming technology is strongly present in the requirements. As mentioned in the introduction, specific technical specifications, such as an optimal encoding option, have not been a part of the requirement definition process. Instead, the technology has been an enabling factor that also has its own limitations.

The defined requirements were divided into two categories. First, the critical requirements were defined. These requirements are considered to be crucial to the observation solution. Second, a set of complementary features was determined. These complementary features are not critical for the solution. Instead, they are various features that may enrich the observation experience and deliver added value to the process but can also be left out if not available. The different factors affecting the requirements are shown in Figure 3-2.

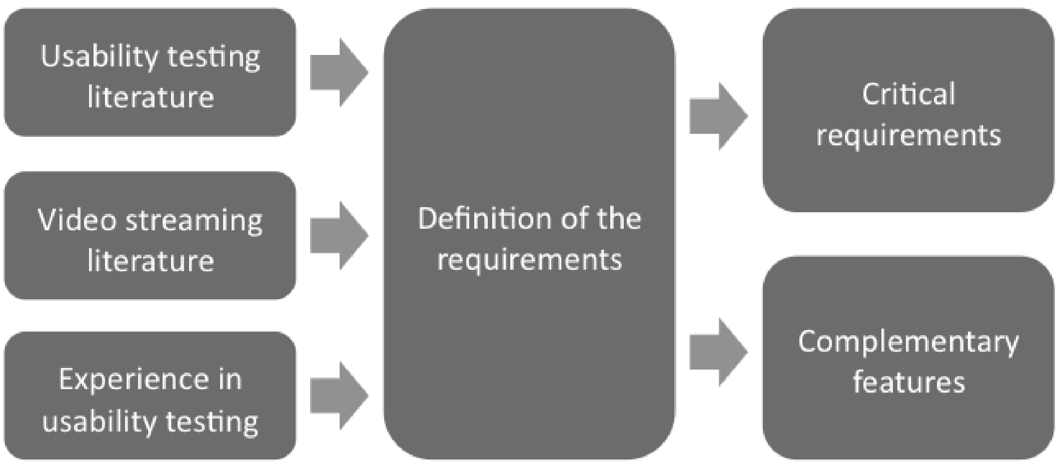

Figure 3-2: The definition of the requirements

3.3 The Search for Solutions

The search for different solutions took place after the requirements were defined. Similarly to the idea generation phase of the product development process, there were many different candidates for the solution. And also just like in product development, in the beginning there was only minimal criticism towards these different candidates. The candidates were initially browsed through and evaluated. A set of promising solutions was filtered out, examined in more detail and filtered further. The result was the set of solutions to be tested in a real usability test environment.

The initial search was done by using online search engines. The search was targeted at all kinds of services: software and even hardware capable of delivering live streaming video over the Internet. Categories such as web conferencing tools, IP cameras and web cameras were browsed through in addition to the obvious video streaming services, platforms and applications.

The large amount of candidates was initially filtered based on features. Many candidates were instantly left out since their focus was too distant from the defined requirements (as described in Chapter 4). This operation produced a set of promising solutions. These solutions were seen as adequate for remote observation of usability tests without any proof of real life performance. However, the set had to be filtered further to keep the workload of the tests within the boundaries of a Master’s thesis.

The larger sets of candidates that were left out were IP cameras, web conferencing applications and services offering only broadcasting. The IP cameras were seen as too inflexible to adapt to different setups, even though they are made for observing events over the Internet. The web conferencing applications were discarded because their focus is too much on the interactive conferencing rather than one-way observation of events. Also, broadcasting services offering no kind of privacy controls were left out because there should at least be on option *not* to broadcast the product prototypes to the whole world, even if the level of privacy would be poor.

The promising solutions from the initial filtering were filtered further by evaluating the features of the candidates further and also by communicating with the service/application providers directly. The further feature-based evaluation of the promising candidates was more of comparison than filtering since all of the candidates seemed promising but only a few would be able to fit the set for the tests. The comparison was also made by communicating with the parties providing the solutions to obtain further details. The communication consisted of emails, calls with sales representatives and meetings with the providers located in Finland. The whole search process including different filtering phases is shown in Figure 3-3.

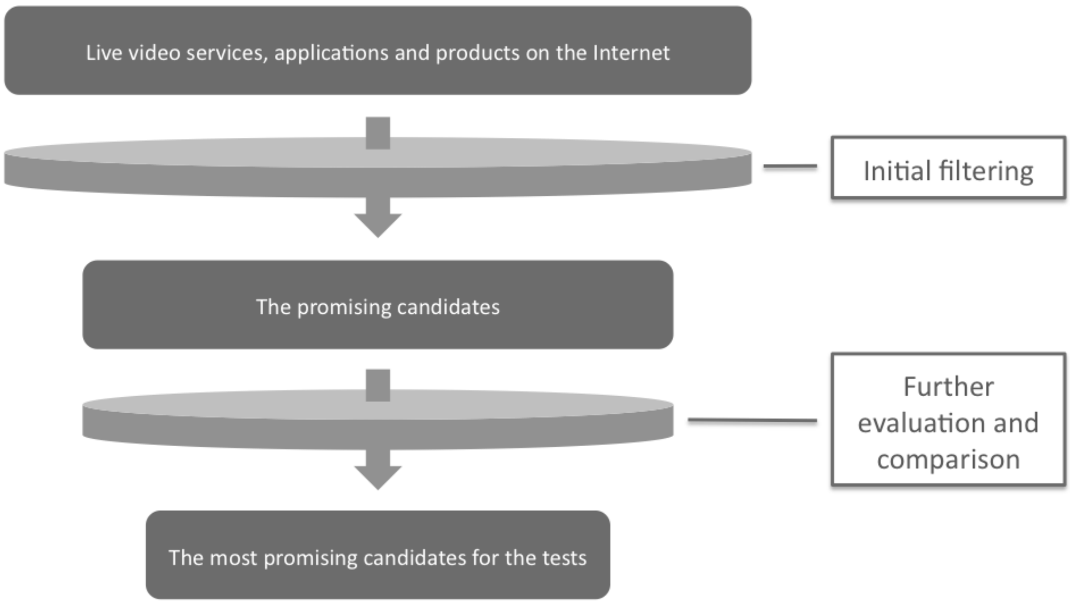

Figure 3-3: The search for the solutions

3.4 Testing the Solutions

After the most promising solutions were found, they were tested in a real usability testing environment. The test sessions were arranged in order to discover the realized quality, effectiveness, utility and functionality of the solutions. There was a total of four tested solutions representing different kind of approaches. Thus, the selection of these four solutions was not only based on how they matched the requirements but also how they could represent as large sample of different approaches as possible. The selected solutions are introduced in more detail in Chapter 5.

The solutions to be tested were selected mainly based on how well they fulfilled the requirements for a remote observation tool for usability testing. The requirements are explained in Chapter 4. In addition to how the requirements were met, the sample of the solutions to be tested was also required to hold multiple differing approaches. For example, testing only instant messaging (IM) services from different providers would not have produced reliable results. Thus, the tested candidates were selected to represent as large a sample as possible in terms of different kinds of approaches.

The objectives and goals of the tests were to find out how the most promising solutions actually work in usability tests. The specific areas of interest were to find out:

- What is the realized video quality?
    - Are the texts (captions, labels, etc.) in the UI distinguishable?
    - Are the visual realizations of interaction distinguishable (e.g. cursor movement)?
- What is the realized audio quality?
    - Are there any difficulties in hearing speech?
    - Are there any difficulties in hearing other audio (e.g. system signals)?
- How complex and time consuming is the setup of the solution?
    - How long (relatively) does it take to have the observation tool up and running?
    - How complex is it to set up the observation tool (e.g. special skills required)?
- Do any other kinds of problems arise during the tests? Just like in usability tests, all of the problem areas are not known in advance and they have to be observed and discovered during the tests.

The definition of the test goals was based on an average usability test setting – what kind of elements should be recognizable when observed via the observation solution. The goals are based on the requirements for a remote observation tool for usability tests (explained in chapter 4). All of the requirements were not tested in practice in these tests to keep the workload reasonable. The goals listed above are the most essential ones for practical testing. They depend on the realized quality instead of the promises of the solutions' providers. However, every solution is screened against all of the requirements by combining the test results with the other data (see Chapter 5).

The test environment imitated a real usability test environment. The test environment was not a genuine usability test for two reasons. First, the usability tests usually involve confidential material, such as the tested prototypes, and are not available for unsecure testing of different kind of video streaming services. Second, the different tasks used in usability tests tend to repeat themselves from an observation-technical viewpoint. It does not take a dozen of similar end user tasks to find out how well the observation tool works.

The test environment was similar to real usability tests except for two minor details. First, the duration of one session was only approximately 5-10 minutes. This was indeed a sufficient time period to define the realized quality of a live streaming tool. A longer period of time would only have been unnecessary repetition. Second, there was only one participant in the tests instead of having a different participant in every session. The participant and the moderator were UX consultants of Etnoteam Finland.

The two consultants imitated usability test sessions in a usability test laboratory and the observation happened in another room. The test premises are illustrated in Figure 3-4. The test setup included the following components:

- A laptop running Windows OS (XP).
- A high quality table microphone and high quality headphones to hear the true quality of the transferred audio.
- Another laptop running Windows OS for the observation.
- A wireless Internet connection used with the streaming tools.

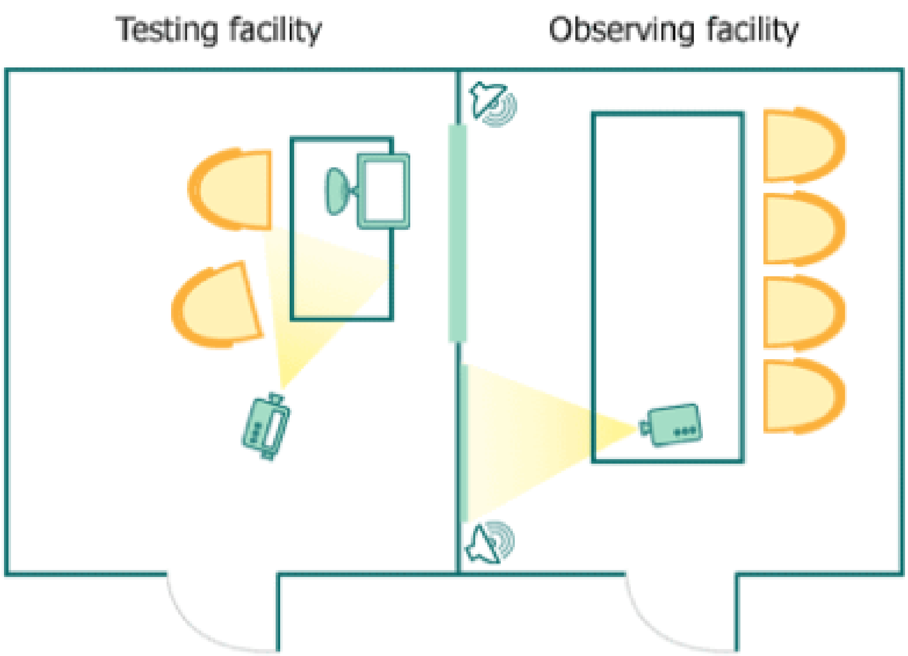

Figure 3-4: The usability test and observation set-up at Etnoteam (Etnoteam Finland, 2010)

The product used in the test sessions was the Etnoteam Finland website. The home page of the website is shown in Figure 3-5. The website was chosen for two reasons. First, it was an already published product and was available to be attached to a Master's thesis. Second, web-based products and services are popular targets of usability tests. Furthermore, it does not really make a difference if the tested software is operated via a web browser or as a native application – the observation procedures are similar in both cases since the product is basically only pixels on a screen.

The website had fonts from size 11 and up. The only way of interaction between the user and the product was made by a mouse – by moving the cursor and clicking links. There were no special system signals involved, but clicking the mouse was a sufficient audio signal to be observed in addition to speech.

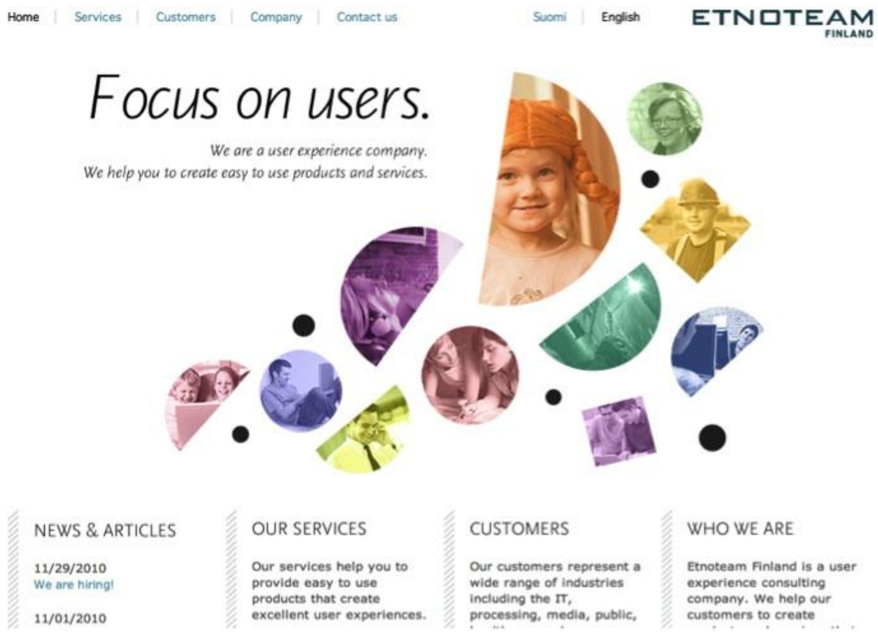

Figure 3-5: The website of Etnoteam Finland

There was no camera involved in the tests. Instead, the desktop of the laptop used in the test room was captured and was used as the primary and only video source. As the tested product was entirely software, there was no reason to use a camera to record a screen. A secondary video source was not used for the sake of simplicity – there was no video of the test participants nor the testing room; the captured desktop was the only video source. The test environment was designed to support the core tasks of the test as well as possible. That is, to find out how the streaming tools work in practice.

The test sessions consisted of events similar to those typically happening in usability tests. The moderator and the participant were discussing the different parts of the user interface (UI). The participant explained her opinions about specific parts of the UI. The participant was also asked to accomplish random tasks on the website, such as to find a piece of information. The participant was using the method of thinking aloud when accomplishing the tasks. The method of thinking aloud allows the observer to follow the participant’s flow, e.g., to understand why the participant navigated herself to a specific part of the UI. Thus, from the observer’s viewpoint, the observation tool was supposed to deliver a synchronous sensation of the events in the software and what is happening in the test room; the observer was following the interactions on the website as a desktop capture video and the synchronous user behavior as the audio from the test room.

3.5 Analysis Based on the Tests and the Feature-based Evaluation

Finally, after the results from the test were obtained, the overall analysis was done. The final results were obtained from the test results and from the feature-based analysis of the most promising solutions that were tested. Thus the answers to the research questions were also obtained from the features and performance of the set of most promising solutions.

The analysis combined the two sources of results and determined in what kind of context the solutions would work. On the other hand, it was also analyzed where they lack the necessary qualities to deliver a satisfying observation experience. During this phase all of the actual results were already obtained. Thus, this phase was merely analyzing different sets of existing results together as one.

4 The Requirements

The requirements for a remote observation tool for usability tests are explained in this chapter. The requirements are divided into two categories called critical requirements and complementary features. The critical requirements are essential to the overall performance of the tool. The complementary features, however, enhance the performance but may be left out if they are not available. The process of obtaining the results is explained in section 3.2.

4.1.1 Critical Requirements

The critical requirements for the remote observation tool are the most important characteristics such a tool has to possess. They are defined from the observer's viewpoint. In other words, the critical requirements define the set of features essential to the core performance of the observer's tool. The critical requirements are summarized in Table 2.

Table 2: The critical requirements for the remote observation tool

Requirement	Reasoning
Video quality Video quality that enables distinguishing different parts of the UI and different ways of interaction.	To make observations and findings during usability tests it is essential to clearly see what is happening.
Audio quality Audio quality that enables to hear the speech and intonation of the people in the test setting and to hear the different audio signals of the UI.	The audio (synchronized with the video) of the usability tests is critical to the complete audiovisual observation experience. Without synchronous and clear audio the context of user comments is in danger of becoming lost, besides the actual comments themselves.

The smooth streaming flow The smooth streaming flow of the audio and video should be possible with the average bandwidth of broadband Internet connections.	The overall required bitrate of the video stream should not exceed the commonly used bandwidths since the uninterrupted and smooth observation experience is essential to making findings and documenting the usability test events.
Test site setup complexity Setting up the tool at the test site should not be complex, technologically or otherwise.	The usability experts conducting the tests should be able to use the tool without any considerable extra effort. Technological background cannot be required of the usability experts.
Observation site setup complexity The observation setup complexity should be low.	As with the previous requirement, the persons observing the tests might be, for instance, people from the product development team and they might be, for example, unable to install extra software on their computers.
The management of the system The management of the system should not be a problem for the test personnel.	The test personnel cannot be expected to have technical background nor time to administrate technical systems. Also reduces complexity (the two requirements above).
Support for video sources Support for various video sources.	A usability test can be observed with only one video source (e.g. desktop capture or a video camera). However, at minimum, the tool needs to support multiple video sources because of different kinds of setups.

Support for audio sources Support for various audio sources.	As in the requirement above, one audio source is sufficient to conduct usability tests but the definition of the audio source should be possible.
Saving the test session videos It should be possible to save the test data.	There might be human errors and interruptions in the observation process and some observations may have to be done after the test sessions. For this purpose there is only one solution – the saved test session videos.
Security There should be at least some level of security of privacy.	The unpublished products should stay unpublished even when tested with the end users. Furthermore, there must be some level of privacy for the participants.

Video Quality

The first and most obvious requirement is the required video quality. Setting any specific requirements for the video quality is not, however, as straightforward as mentioning it. Any specific technological parameters of the video are not the primary interest since there simply is no single right way to define the technological video quality. Instead, the different goals for the video are defined.

The video should deliver a visual experience similar to observing usability tests right where they are happening. The events of a usability tests should be as clear as if the remote observer would be next to the test participant. The problems and findings that arise during usability test sessions relate to the use of the prototype and it is indeed the use of the prototype that should be visible in the video. Depending on the product, the use might be clicking different graphical items on a screen with a pointer device or it might be something that the participant is doing with their hands, e.g., different gestures to control a device. The video quality should not weaken the observer's perception of these kinds of events.

Even though no single video parameter set can be defined, some direction and boundaries can be set. There are many ways to measure video quality. The frame rate, the resolution and the encoding are rather simple video characteristics that can give some estimation for the required level of video quality.

Even though the traditional television content frame rate in Europe is 25 frames per second (Silva, 2011) and the latest smartphone from Apple records and plays video with a frame rate of even 30 frames per second (Apple, 2011), the remote observation tool would function well with much less. The tool is not about entertainment or slow motion effects, and thus a frame rate as low as only ten frames per second should be sufficient. That frame rate shows the different motions smoothly enough to see what is happening at a usability test. One has to remember that these parameter values are not absolute; having a frame rate of 9 frames per second would probably not change anything from the observer's viewpoint.

The resolution and the encoding should be considered in a similar manner. For example, the lowest resolution video on Youtube is 240p, that is, 320 by 240 pixels. With proper encoding (that does not lose too much data) 240p can be discovered to be enough to accomplish the goals of usability test observation. Lowering the quality from the Youtube example would, however, begin to affect how, for instance, various items would stand out on a screen of a mobile device. Moreover, it is up to the level of detail in the prototype what level of resolution is sufficient. A resolution of 240p is certainly not enough for a product including lots of text in small font size.

Audio Quality

The audio quality must be defined similarly. The observer is required to hear the speech in the test room and the various possible audio signals of the UI. Hearing especially what the participant is saying, for example, why the participant selected a particular item in the UI, is essential to making observations in usability tests. The different audio signals of the UI or the product are also important to be heard clearly and in synchronization with the video to fully understand and follow the events of a usability test.

The audio is also encoded like the video that has been discussed. There is no single right way for the technical audio parameters to be set. However, as comparison, the quality of a speech recording with a bitrate of 64 kilobits per second should be close to the original recording using the popular mp3-encoding and 192 kilobits per second should already deliver a decent music listening experience (Kayne, 2010). It must be remembered that the remote observation tool is not about entertainment, even though better quality will be easier to follow.

The Smooth Streaming Flow

Related greatly to the video and audio quality, it is of great importance that the smooth streaming flow of the audio and video should be enabled with the commonly available average bandwidths of broadband Internet connections. If the stream consumes too much bandwidth, excessive buffering is to be expected. From the observer's viewpoint, the observation experience must not be cut in the middle of a test session. This would interrupt the observation flow and might even prevent some findings from being found. Thus the previously mentioned adaptive bitrate streaming would probably be highly useful to the cause. It should also be noted that the entire bandwidth is not always entirely exploitable for the observation tool.

Test Site Setup Complexity

In addition to the actual observation experience, also the tool itself has to fulfill a certain level of usability and ease of use. The complexity and required effort to integrate the tool as a part of a usability test setup should be rather low. The usability test setup has its own challenges and using a remote observation tool should not shift the focus away from the testing procedure itself. The usability experts conducting the tests should be able to use the tool without any considerable extra effort. A technological background cannot be required of the usability experts.

Observation Site Setup Complexity

Also the other end of the tool should not be unnecessarily complex. Watching a video should not require more than a web address and possibly authentication. The persons observing the tests might be, for instance, people from the product development team and they might be unable to, for example, install extra software on their computers. Also different kind of corporate firewalls might even block all exotic streaming solutions. Thus the discussed HTTP-based streaming solutions would probably come in handy.

The Management of the System

In addition to the points related to complexity above, the management of the system should not be the worry of the usability experts. The test personnel should not be expected to have a technical background nor time to administrate technical systems.

Having, for example, a Software-as-a-Service (SaaS) approach in the tool would enable a flexible approach. With SaaS, the customer only rents and uses the software and saves the trouble of installing and deploying the software (ebHostingSearch, 2010). The hosting of the content is especially a relevant question. With a SaaS-approach, the usability team is only concerned with the actual use of the service and may focus its efforts on the usability testing. Whatever the approach is, the management of the system should not be of large concern for the usability test personnel.

Support of Video Sources & Support of Audio Sources

As to the number of different video and audio sources, one of each is sufficient to conduct a usability test. However, at minimum, the tool needs to support multiple different video and audio sources. Even though a specific usability test could be conducted with, for instance, the built-in camera and microphone of a computer, different usability tests require different setups. Different video and audio sources should be supported, one video source and one audio source at a time at minimum, to allow the usability tests to be conducted without unreasonable limitations concerning different setups.

Saving the Test Session Videos

However, there is always a risk of errors in the Internet and there might be human errors and interruptions in the observation process and some observations may have to be done after the test sessions. For this purpose there is only one solution – the saved test session videos. Even though the realized quality of the live video stream would be below a satisfying level the test sessions could be observed from the saved video files as an on-demand video stream. Thus there must be an option to observe the test sessions from recordings even after the sessions.

Security

Finally, the tool should have at least some level of security of privacy. The unpublished products should stay unpublished even when tested with the end users. The security is considered here as an on/off feature rather than assessing the realized level of security of a particular security setting. It can be stated, however, that without any level of security of privacy there is only minimal potential for using such a solution with usability testing.

4.1.2 Complementary Features

The different complementary features are not required of the remote observation tool. Instead, they are different nice-to-have features that would help in the context of usability testing and usability test observation. The different complementary features are summarized in Table 3.

Table 3: The complementary features for the remote observation tool

Feature	Reasoning
Multiple simultaneous video channels	Having different video feeds would give more perspective to the events of a usability test.
A second separate audio channel	Another audio channel would allow listening to either the original audio or the interpretation.
Reliable global coverage	Product development and usability testing is all over the world and there is no reason why the tool should only work in certain parts of the world.

Remote camera control	Remotely controlling the camera would allow the observer to focus on special points of interest.
Interaction Integrated interaction functionality between parties involved in the testing process.	Easily enabled communication would increase the synergy between the parties.
VCR capabilities Video recorder capabilities with live video.	Instantly replaying an event could erase the need to go through the saved videos afterwards.
Live editing	Letting the testing party to, e.g., switch between video sources could give the same benefit as multiple video channels.
High definition (HD)	The current standard of high quality entertainment would maximize the observation experience on modern television sets and projectors.
3D video technology	3D would bring the observer closer to actually being present in the tests. Might be available in the future.

Multiple Simultaneous Video Channels

Having more than one video source would allow the observer to have more perspective to the events of a usability test. For example, adding a video of the participants face in addition to the desktop capture would enable the observer to see the facial expressions of the participant in the context of different events of the test. This kind of feature could be implemented as picture-in-picture (PiP) functionality, where the secondary video feed is placed on top of the primary video feed as a small box of content.

A Second Separate Audio Channel

Even though one audio channel can deliver the audio of multiple microphones mixed together, having a second separate audio channel would allow the observer to choose between the original audio and the interpretation. Interpretation might be used in usability tests if the observers do not master the language of the participants. For example in Finland, usability tests might be translated into English by live interpretation. The two channels of stereo sound could be exploited by panning the two audio channels into the left and right channel. The best case scenario would be that the audio source could be selected like the subtitles in movie recordings.

Reliable Global Coverage

Product development and usability testing is all over the world and there is no reason why the tool should only work in certain parts of the world. Thus a previously described content delivery network or a similar quality assurance would increase the utility of the solution. If a usability test is being conducted on a whole different continent, the uninterrupted observation experience is highly important since the analysis of the usability tests might only be based on the observations made with the remote observation tool. On the other hand, more or less local usability testing does not require any special global coverage assurance. Furthermore, even global tests can be observed from the saved session videos and it might even be the optimal choice in case of time zone related difficulties.

Remote Camera Control

In addition to multiple simultaneous video sources, remotely controlling the camera would allow the observer to focus on special points of interest. The remote control of one camera does not deliver the same observation perspective as multiple video sources but it does offer more flexibility since the observer would be in control of the exact video feed.

Interaction

Interaction between the remote observer and the testing party (or between observers) would increase the synergy of their collaborative involvement. If the live observation tool would offer an integrated means of communication, for example an IM option, the information and requests of both parties could be taken into account. For example, if there is no remotely controllable camera and the observer would wish to see a different angle, an IM option could deliver such information to the testing party even in the middle of a test. The worst case scenario in the example would be that the camera is at an inefficient angle during a whole test session and the observation would thus be also inefficient. However, the interaction can be achieved with the numerous communication possibilities available (from telephones to chat clients) and is not a critical requirement.

VCR Capabilities

Different kinds of video recorder capabilities, such as pause and rewind, could also be beneficial if implemented into the live streaming tool. If the observer misses an event they could instantly check it before losing the context. The live stream would then resume where it was left off. Being able to have some control over the video, even if live, would remove some of the need to check events from recordings afterwards. These capabilities are of course present in the case of on-demand video. Even though it was critical that the observation experience does not get interrupted, the choice of using, for instance, a rewind function would be in the hands of the observer.

Live Editing

The live editing of video would allow the testing party to, e.g., switch between video sources in the middle of the test. This could bring the same kind of benefit as multiple video channels or remotely controllable cameras but would require efforts from the testing party that already has the actual test on their hands. However, live editing of video would allow the observer to focus on observing. The testing party would probably know better when to switch between video sources, for example from a camera to a desktop capture, since they are in control of the test.

High Definition (HD)

Even though it has been stressed that the remote observation tool is not for entertainment, having high definition standard video would allow a) a high quality viewing experience and b) seamless integration with the high definition capable equipment, like television sets and projectors. High definition would enable the full advantage of large screen sizes and also enable more fine-grained observation. However, high definition would also require high bandwidth and should be considered carefully.

3D Video Technology

The final complementary feature is 3D technology. It is meant to be a wild card and is probably not feasible to implement to the tool currently. The technology would, however, bring the observer closer to being actually present at the tests with the sensation of three dimensions. The current developments involve Toshiba’s recently announced product line of televisions capable of delivering a 3D experience without any kind of glasses for the viewers (Adhikari, 2010). It is yet to be seen if usability tests can be observed remotely with holograms in the future.

5 The Solutions

The most promising currently available solutions for remote live observation of usability tests are introduced and described in this chapter. Four different solutions are selected to represent different approaches. The first solution is Morae, a tool meant specifically for usability testing and is also capable of live streaming. The second solution to be introduced is Skype, a popular Internet calling / instant messaging / video calling service. The third solution is Livestream, a popular web service for live video streaming. The fourth and final solution is an application customized for live streaming of usability tests. It is a combination of a live media encoder and a hosted website for the observation. The four solutions represent different approaches: Morae is a usability testing application, Skype is an IM service, Livestream is a SaaS-based generic live streaming service and the customized application is a usability testing application that has live streaming as the top priority.

The chapter discusses each solution individually. For each solution, the solution itself is introduced first. Then, the solution-specific test results are introduced. Each solution was tested in a real usability test environment to find out the realized performance and complexity of the solutions. The tests assess how the solutions actually performed instead of assessing how they should work according to the companies offering the services. The goals and process of the tests are explained in Section 3.4. After the test results, the solution-specific overall results are discussed. These results are the final results of how the solution scored against the requirements defined in Chapter 4. The overall results focus on the critical requirements. The complementary features are seen as on/off -features and are only mentioned without any further analysis if supported. Finally, a brief comparison of the solutions is introduced. The overall results of all of the solutions together can be seen in Appendix 1.

5.1 Morae

Morae is a usability testing and market research software tool by TechSmith. The main focus is on software and website usability testing. It has separate applications for recording and observing an event and it also offers an application for managing and analyzing the recorded data. The software works only with the Windows operating system and requires installation. The observation application is freely downloadable, but the actual software requires a license. (TechSmith Corporation, 2011)

Morae was chosen because it is a popular tool used in usability testing. It is designed for usability testing in particular and it supports remote observation. Thus it fulfills many of the requirements defined in chapter 4.

Morae supports various video and audio sources and even PiP functionality. It supports recording and sharing of the sessions. There is an option for security in Morae; it supports observation within a virtual private network. However, the actual live streaming quality is not guaranteed in any way and the setup might be complex for a first-timer. The observation framework from TechSmith's viewpoint is shown in Figure 5-1.

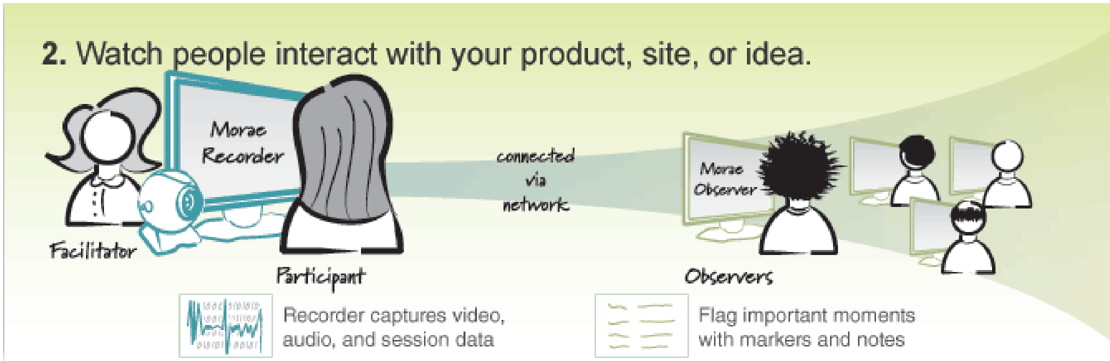

Figure 5-1: Observation with Morae (TechSmith Corporation, 2011)

Morae has also other features in addition to the matches with the defined requirements. It allows the observer to add custom markers to the timeline in real time – to mark special and interesting events during the test session. It also supports capturing mouse and keyboard input and showing, for instance, mouse clicks with a special effect during the observation.

5.1.1 Morae's Test Results

Morae performed rather poorly in the test; the video quality was low and the setup complexity was high. The overall test results of Morae are summarized in Table 4.

Table 4: The test results of Morae

Video	Audio	Setup	Other

Text was hardly readable.	No problems.	Software installation required. The connection requires the knowledge of the transmitting computer’s IP address.	Low frame rate.

The video quality of Morae was somewhat disappointing. Morae was the only solution that had trouble delivering sufficient video quality. The smallest texts of the website were not really readable. This may not be critical since the people following or observing usability tests should be familiar with the product in question and should be able to follow and observe the test sessions without effort. However, there were no problems in following the cursor movement and the overall ongoing interaction.

The audio quality of Morae was sufficient. Listening to the people talking in the test room required no effort. Even the mouse clicks were perfectly audible. The audio was synchronized with the video.

The complexity of the setup in the case of Morae was relatively high. The different pieces of software for the transmitting and the observation had to be installed and the connection between them had to be made with the IP address of the transmitting computer. The computers that are to observe the stream of the transmitting computer need the IP address of the transmitting computer. If the two parties are far apart, the IP address needs to be communicated somehow, which adds complexity to the process. It must be noted that the tests addressed the complexity and workload of the setup for a first-timer. Of course, the workload decreases once the software is already installed and the user is more familiar with the application. The transmitting and observation in case of Morae are illustrated as screenshots in Figure 5-2 and Figure 5-3.

Concerning the other findings in the case of Morae, the setup requires a minimum of two computers running the Windows operating system. However the tests are arranged and the observation is located, the presence of Windows computers is required. Furthermore, the installation of software is also necessary, which is not self-evident for company-owned hardware. Companies might have strict rules and restrictions about installing software on their computers. In addition to the mobility issues related to the Windows computers, the realized frame rate was low and was unpleasant to watch even though it did not directly harm the observation process.

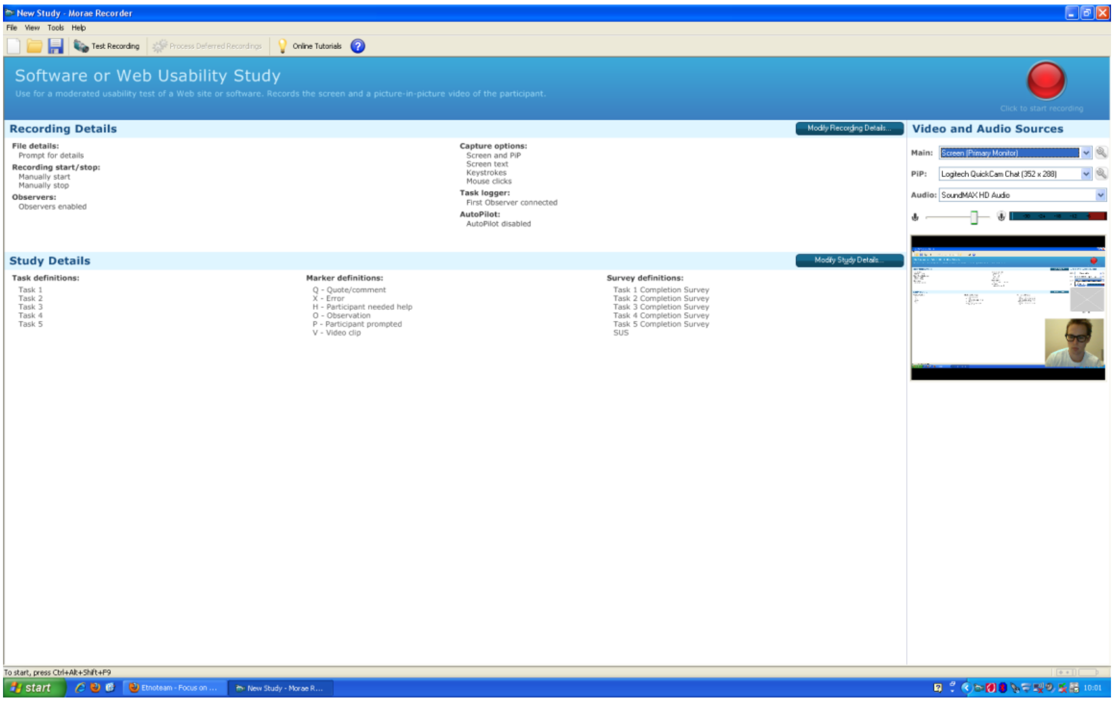

Figure 5-2: Transmitting with Morae

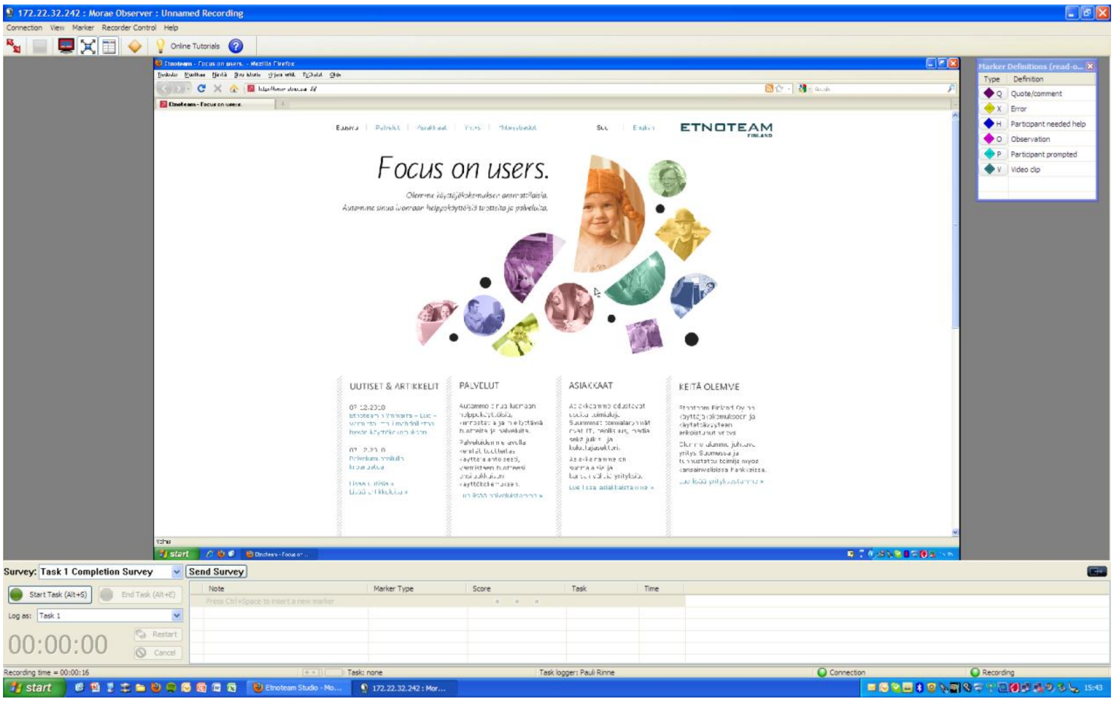

Figure 5-3: Observation with Morae

5.1.2 Morae’s Overall Results

Morae might have been the favorite pre-analysis choice because of its popularity as a usability testing application but the results tell another story. Even though Morae is the popular choice for digital usability testing, the video quality and the streaming of the video to a remote location seem to be poorly implemented. Perhaps the focus is too much on the usability testing and the actual video related technology has been left with inadequate attention while developing Morae. The overall results of Morae are summarized in Table 5.

Table 5: Morae's overall results

Video quality	Below requirements, e.g., 13p font not readable.
Audio quality	Good.
The smooth streaming flow	No guarantees.
Test site setup complexity	Installation and Windows OS required.

Observation site setup complexity	Transmitter's IP address required in addition to the above.
The management of the system	By TechSmith.
Support of video sources	Supported.
Support of audio sources	Supported.
Saving the test session videos	Supported, locally or to TechSmith service.
Security	Yes, VPN option.
Complementary features	Only PiP.

What Morae does well is fit right in the process of usability testing. Since it has the usability test related observation markers feature along with a few other nice additions and the interoperability with the other TechSmith products, Morae is a decent tool in a usability test setup. For example, Morae includes an application for the analysis of the test sessions. Furthermore, the ability to automatically save, store and share the test session videos in a secure way is an important part of the utility of Morae.

Anyway, the objective was to find a proper usability test observation tool and Morae is not the most proper tool for observing a remote live usability test. Morae is capable of delivering live video but does not offer decent quality over the Internet. The situation might be different if Morae could be attached to a CDN or to any additional streaming technology provider with guarantees on the delivery and quality.

The setup of Morae itself is not modern. Having only native Windows applications available is a rather limited way to implement software when there is a chance to use SaaS-technology and to implement cross-device and cross-platform support for all kinds of different devices in the market. Furthermore, the software itself requires unintuitive – or too much technologically oriented – operation. For example, the connection between the observation software and the transmitting software has to be made by entering the IP address of the transmitting computer to the observation computer. Thus, the level of usability in the usability testing application itself is not optimal.

5.2 Skype

Skype is a much discussed cross-device and cross-platform service for making free calls over the Internet, including video calls and desktop capturing. There are even Skype-ready televisions available. Skype requires installation just like Morae but supports multiple devices and operating systems. It should be also noted that the basic version of Skype is offered free of charge. (Skype Limited, 2011)

Skype was chosen because it supports secure live video and has a huge installed base even though it has the focus of two-way communication and does not have built-in support for recording the sessions. What it does have is hundreds of millions of users, 560 million in the beginning of 2010 (Malik, 2010), and a user-friendly interface – and of course much success in the Internet calling business.

Skype’s strengths in terms of quality are the support up to HD video quality and the peer-to-peer (P2P) approach in the delivery of the content. Shortly put, P2P uses the capacity of the peers, the other users, to deliver the data instead of centralized servers. In the beginning of 2010, Skype had 23 million online users at peak hours (Malik, 2010). Having such a large and active user base for the data delivery, technological performance should not be an issue. Concerning security, Skype uses the Rijndael standard (used also by the US Government organizations to protect sensitive information) to encrypt the traffic. Skype also supports instant messaging and live editing – at least switching between a camera and a computer desktop. In short, Skype should be reliable and is available for everyone. (Skype Limited, 2011)

The weakness of Skype is simply that it is not made for observation purposes. There is a risk of unintentional audio and video transmission from the observers to the testing site. Furthermore, Skype does not support multiple simultaneous video sources and requires separate user accounts for all of the devices involved. However, with the newly added group video calling feature there could be multiple video sources if multiple computers with separate accounts are used. (Skype Limited, 2011)

Skype does not support recording of the events and thus 3rd party software is required to fulfill the critical requirement of saving the test sessions for later observation.

5.2.1 Skype's Test Results

Skype performed quite well in the test; the media quality was excellent but on the other hand the setup procedures were not optimal. The setup is not complex, but requires separate Skype accounts for all of the computers involved in the process. The overall test results of Skype are summarized in Table 6.

Table 6: The test results of Skype

Video	Audio	Setup	Other
No problems.	No problems.	Easy but requires installation and user accounts.	Rather low frame rate. Risk of unintentional two-way communication.

The video quality of Skype was excellent. No complaints can be made since even the smallest texts were easily readable. Also the interaction, mostly the cursor movement, could be observed without effort.

The audio quality of Skype was also as good as the video. After all, Skype is an Internet calling application. Speech was clear as were the other sounds in the testing room also.

The complexity of Skype's setup was somewhat troubling to assess. The basic functionality of the application is extremely intuitive and requires minimal effort. The trick is that the application requires separate personal user accounts. Moreover, the application is meant for interactive communication and requires extreme care to prevent unintentional traffic from the observer to the testing party. For example, if the microphone of the observing computer is left switched on and the speakers of the computer used in the testing room are on, the noise made by the observer is transmitted to the testing room. As to the user accounts, if the number of remote observers is unknown and they have no existing Skype accounts, they must either create the accounts for themselves or the testing party must create a sufficient number of observation accounts and pass the login information to the observers. The transmitting and observation in the Skype case are illustrated as screenshots in Figure 5-4 and Figure 5-5.

It was also noticed that the frame rate of Skype was not astonishing. It was not bad at all, but the cursor movement, for example, was not as smooth as it could have been.

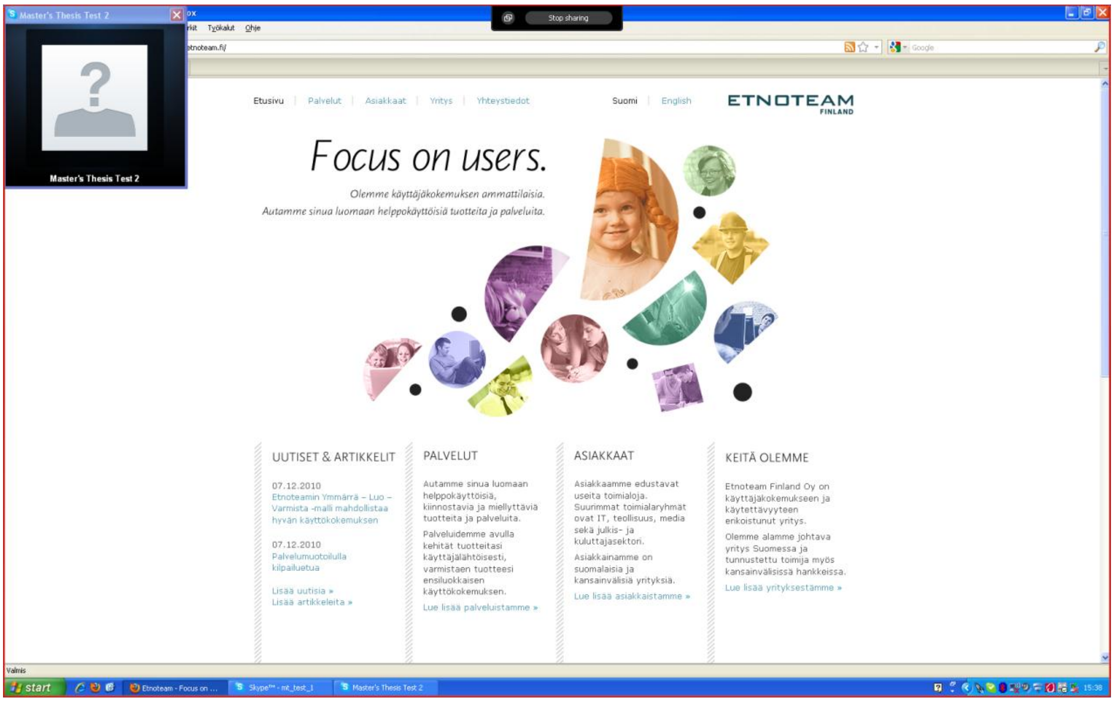

Figure 5-4: Transmitting with Skype

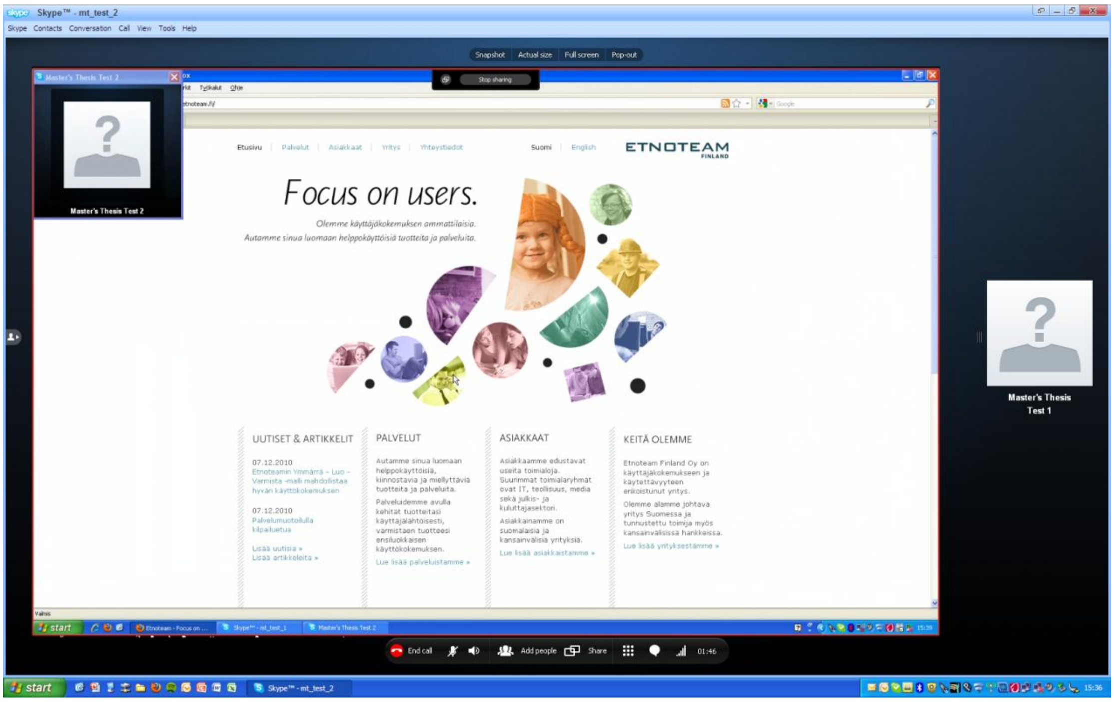

Figure 5-5: Observation with Skype

5.2.2 Skype's Overall Results

Skype proved to be a good and relatively simple budget-wise choice. Skype, however, lacks the feature of saving the videos and neither offers any kind of service for sharing the saved videos. On the other hand, the basic performance was mostly above requirements. The overall results of Skype are summarized in Table 7.

Table 7: Skype's overall results

Video quality	Excellent.
Audio quality	Excellent.
The smooth streaming flow	A large P2P network.
Test site setup complexity	Installation required, a user account required.

Observation site setup complexity	Installation required, a user account required.
The management of the system	No hosting available.
Support of video sources	Supported.
Support of audio sources	Supported.
Saving the test session videos	No built-in support.
Security	Yes, 256-bit Rijndael encryption.
Complementary features	Multiple video sources by group video chat with multiple computers, large global P2P network for global delivery, interaction by IM, calling or video chat, live editing, high definition support.

Unlike Morae, Skype's video quality is excellent but the application itself is not the easiest one to be integrated into the usability testing process. Skype's huge assets in the analysis are the quality of the video and the effective and secure delivery of the stream that result mainly from the huge P2P network. The application itself is effortless and intuitive – it has to be because it serves such a large audience. Even though Skype has to be installed it operates on different devices and operating systems. The installation process is seen as unnecessary extra trouble from the viewpoint of usability testing since installing software is not always possible, for instance, if the users do not have the required privileges to install additional software.

Skype was known to be built for communication instead of focusing on one-way streaming. Skype does have the heavy drawbacks of missing support for recording the videos and having a potential risk for unintended two-way communication. If the videos of the sessions are not required for some reason, Skype would be an excellent choice. In case they are, 3rd party software is required - which adds risk and complexity into the process. However, one must be really careful to disable the communications from the observers to the testing site during the test sessions. It would be unimaginably troubling if, for example, the comments of the product developers observing the tests would come out of the speakers at the test site. That would disturb the test participant and thus corrupt the observations and the test results.

5.3 Livestream

The third solution is Livestream, a SaaS-based service meant for streaming live video in general. It supports live video streaming operable entirely with a web browser including a hosted web page for viewing the video. Thus, what it does also deliver is an approach independent of hardware and software - it can be accessed and used anywhere where there is a device connected to the Internet. Livestream also offers an installable application to overcome different limitations of web browsers, for example, allowing different additional features. Usability testing can take place in the most exotic of places and the SaaS-approach of Livestream takes flexibility to the fullest. Moreover, the observation can be also done with a mobile device while on the move. (Livestream, 2011)

The basic version of the service is free and concerns only broadcasting and sharing of events – it offers no privacy. The premium service does offer security with many other features and thus the premium version is considered to be the solution even though the free version was tested. (Livestream, 2011)

Livestream was chosen to represent the various web-based services offering live streaming because of the privacy and other features available. Livestream is also far from a niche player, judging only by looking at the pick of the customers using their video platform – everything from TV stations to newspapers. Livestream offers quality up to HD, support for different video and audio sources, PiP, live editing, IM support, CDN support, privacy, recording of events for on-demand use and a SaaS-approach. (Livestream, 2011)

So far it seems too good to be true. The downside is that the cost is from $3500 to $12500 per year, or higher, depending on the required capacity and other premium features. Even though the financial side of the solution is not in the interest of this thesis, the cost must be mentioned. (Livestream, 2011)

5.3.1 Livestream's Test Results

Livestream showed the best performance in the tests; there were absolutely no problems of considerable size. The overall test results of Livestream are summarized in Table 8.

Table 8: The test results of Livestream

Video	Audio	Setup	Other
No problems.	No problems.	As easy as it gets.	Short buffering breaks.

The video quality of Livestream was equally good compared to Skype. All of the parts of the UI were distinguishable; all of the texts readable without effort and the cursor movement could even be highlighted with a glow effect.

The audio quality of Livestream was also excellent, like in Skype. In addition to the fact that speech and other sounds from the test room were clear the audio quality was a joy to listen to.

Livestream's setup was as easy as it gets. The minimum that was required included a login to a website and starting the streaming process with the press of a button. The observation side setup required only accessing the easy web address of the stream, livestream.com/streamname, and all was done. The installed application of Livestream was used in the test and in a real life scenario the observation would have required authentication. The application was comparable to Skype in terms of setup workload and intuitiveness. The setup is shown in Figure 5-6 and Figure 5-7.

While observing the video stream of Livestream, there were short buffering breaks. The breaks might have been due to various reasons including any temporary problems with the wireless Internet connection. It should also be noted that the free version of Livestream did not have CDN support. Whatever the cause of the buffering breaks was, it should be noted that there were no breaks with Skype or Morae, even short ones.

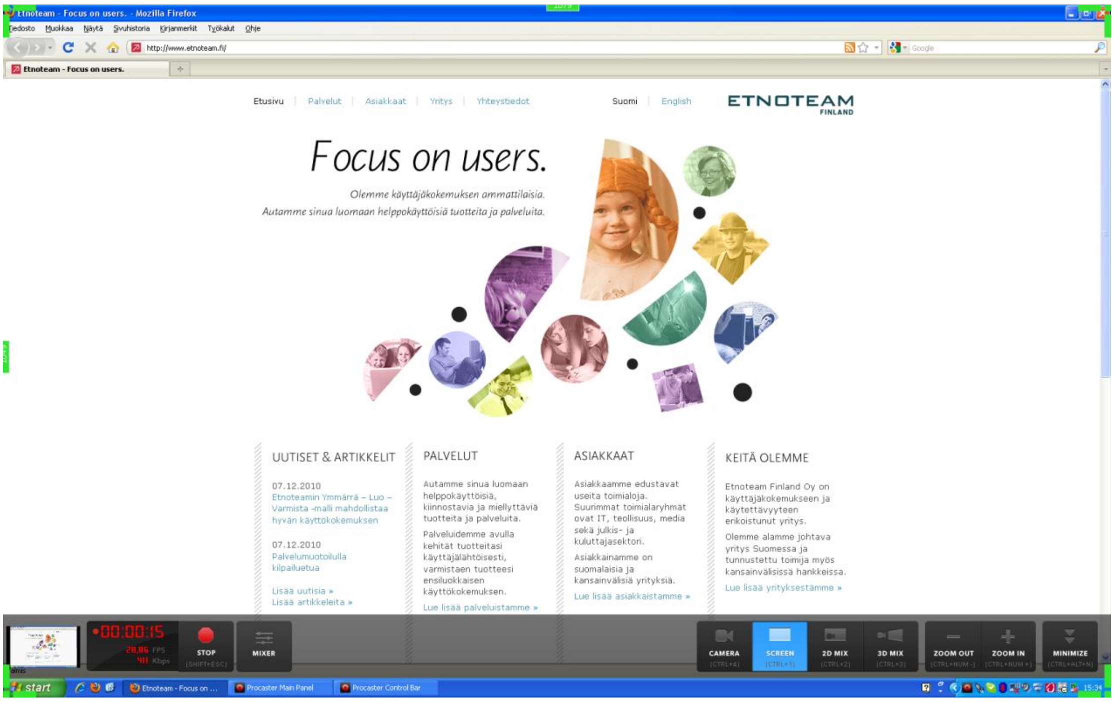

Figure 5-6: Transmitting with Livestream

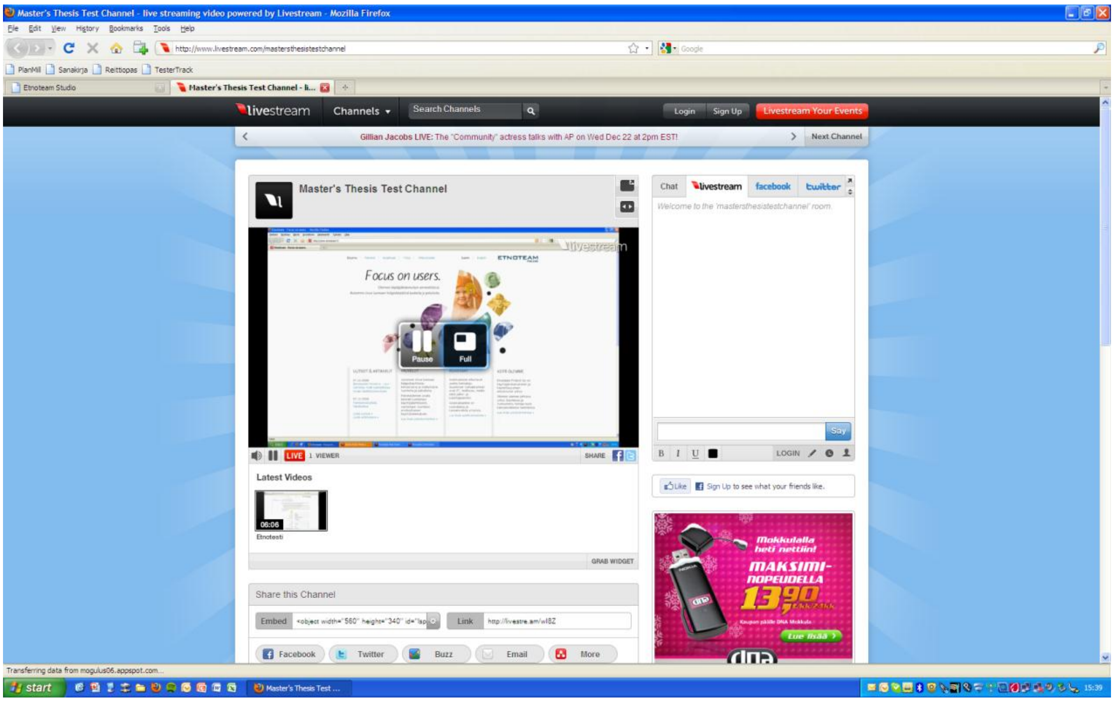

Figure 5-7: Observation with Livestream

5.3.2 Livestream's Overall Results

Livestream delivers its promises: easy live streaming of one's events over the Internet. Livestream was extremely easy to use, the setup was simple and the quality was excellent. The overall results of Livestream are summarized in Table 9.

Table 9: The overall results of Livestream

Video quality	Excellent.
Audio quality	Excellent.
The smooth streaming flow	CDN.
Test site setup complexity	SaaS.
Observation site setup complexity	SaaS.
The management of the system	SaaS.
Support of video sources	Supported.
Support of audio sources	Supported.
Saving the test session videos	Supported, SaaS.
Security	Yes, privacy as a premium service.
Complementary features	PiP, CDN, IM, Live editing, HD support.

In addition to the SaaS-approach, Livestream also offers an installable version of the service. The installed application increases the performance and number of available features of the service. Having both options is the most that can be asked for in terms of software implementation.

The video quality of Livestream is excellent and the delivery is guaranteed by a CDN. However, Livestream does not mention adaptive bitrates and there were short buffering breaks during the tests. It might be the case that the transmitter has to manually control the quality of the video in order to prevent any buffering breaks. Anyway, the overall technical performance of Livestream was above requirements and the CDN support was not enabled in the tests because the free version was used.

Livestream also offers a number of additional features. Most of them are available via the installable application for transmitting. Live editing, chatting and PiP are only a few of the set of features from which one can find the features one needs. Even though the persons at the test sites might be occupied with the test sessions themselves, the features are a welcome bonus in addition to the core utility.

The downside of Livestream is that privacy is only available for those with funds. One of the critical requirements was that some level of privacy must exist. The free version offers only broadcasting for the world and the premium service is expensive. Other than to the price, there are no major downsides in Livestream.

5.4 The Customized Solution

The last solution is a customized application/service designed for the live streaming of usability tests. The difference from Morae is that the TechSmith’s application has its focus on usability testing with all kinds of additional features, not the live streaming of the media itself.

The customized application is a demonstrational development version of the actual application. It consists of a freely available application, the Flash Media Live Encoder, and a website for watching the video.

The Flash Media Live Encoder supports a wide variety of media sources and other settings. The video parameters can be set precisely if one knows how to adjust different technical parameter values. A profile file can be used to set all of the difficult parameters to desired levels.

However, the solution does not support any of the complementary features. Since the solution is a demo version it must be assumed that the critical requirements would be fulfilled at least in the most minimal way when assessing the features on paper. The actual performance was still evaluated in the tests. Thus the evaluation of the customized application is a mixture of assessing future promises and current demo quality.

5.4.1 The Customized Solution's Test Results

The customized solution performed quite poorly in the test; the media quality was sufficient but the setup was troublesome and there were serious buffering breaks. The overall test results of the customized solution are summarized in Table 10.

Table 10: The test results of the customized solution

Video	Audio	Setup	Other
No problems.	No problems.	Flash Media Live Encoder requires technical knowledge or a separate video profile file. 3rd party software for desktop capture required.	Serious buffering breaks. Bad interoperability with 3rd party desktop capture software.

The video quality of the customized application was satisfactory since all of the UI content was recognizable. However, the quality was not even close to the quality of Skype or Livestream. This may be due to the settings in Flash Media Live Encoder since a predefined set of settings was used.

The audio quality of the customized application was satisfactory. As with the video, there was nothing that would have stood in the way of a usability test observation. Still, the quality was not as good as with Skype.

The complexity of the customized application's setup was the most disappointing. It required the Flash application to be installed, a separate profile file to be used with the Flash application, 3rd party desktop capture software for the Flash application and would have required media streaming expertise if something would have gone wrong with the Flash application. The profile file is a separate file containing all of the parameter values for transmitting a video stream with the Flash application. The profile file needs to be opened locally with the Flash application. The 3rd party desktop capture application is a small piece of software that delivers the desktop as a video source. The Flash application does not have built-in support for capturing the desktop and thus needs such an application in order to select the desktop as the video source. The Flash Media Live Encoder and the observation site are shown in Figure 5-8 and Figure 5-9.

There was only one 3rd party desktop capture application from two popular ones that worked with the Flash application. Even with the interoperable desktop capture application only a resolution of 320 times 240 pixels was functioning well. Even that resolution was a cropped part of the desktop instead of a downscaled version of the whole desktop. Using a higher resolution resulted in a screen where half was captured from the source and half was filled with a single color. The two desktop capture applications were the first hits on Google and also recommended on several discussion boards. The low resolution was accepted since that would have been the situation also in real life usability tests where there is not too much extra time to test a dozen different desktop capture applications. If a test would have been held abroad for the first time with a similar setup, the results would have been the same. 3rd party software is a multiplier for risk since the amount of different parts increases. However, the resolution was enough to observe that the video quality of the solution is sufficient.

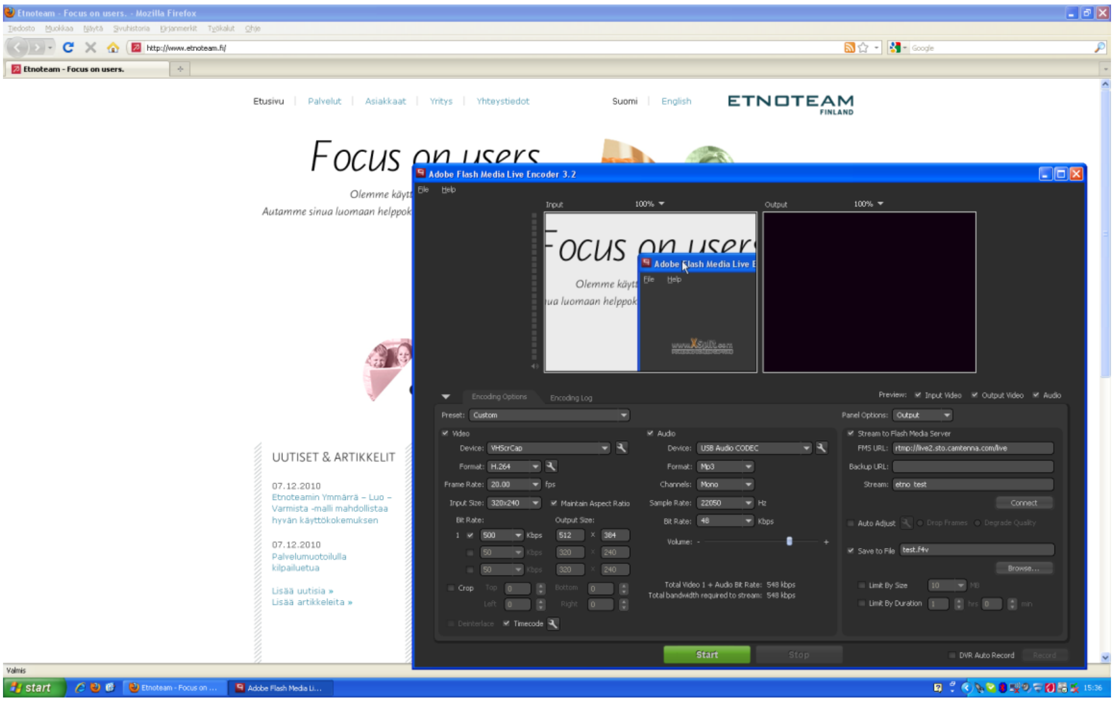

Figure 5-8: Transmitting with Flash Media Live Encoder

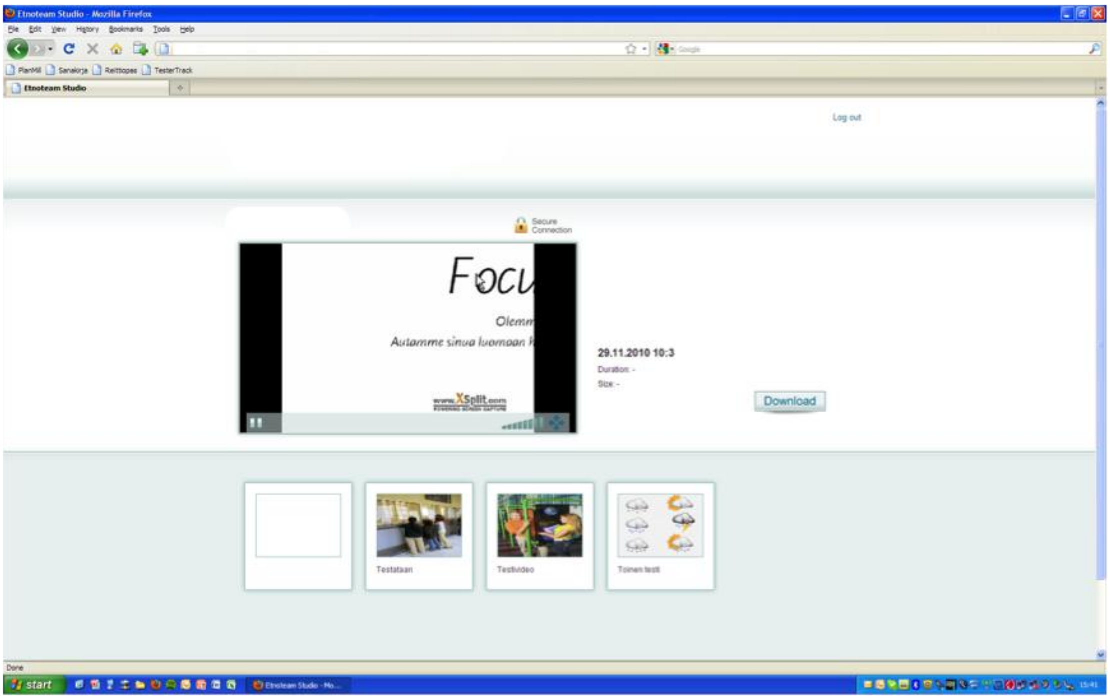

Figure 5-9: Observation with the customized solution

5.4.2 The Customized Solution's Overall Results

The customized application was a demonstrational development version and many different issues have to be analyzed considering the full version instead of the tested version. The video quality will be enough, the service will have global coverage and better video delivery with a CDN and the sessions will be recordable. The solution will be enough for the observation of usability tests (that is the primary goal of the development) – if the test site personnel manage to set the system up. The overall results of the customized application are summarized in Table 11.

Table 11: The overall results of the customized application

Video quality	Sufficient.
Audio quality	Good.
The smooth streaming flow	CDN.
Test site setup complexity	Installation, profile file (or expertise) and possibly a desktop capture application required.
Observation site setup complexity	SaaS.
The management of the system	SaaS.
Support of video sources	Supported, no built-in desktop capture.
Support of audio sources	Supported.
Saving the test session videos	Supported, SaaS.
Security	Yes, SSL encryption.
Complementary features	Only CDN support.

The transmitting setup holds many risks of failure. The use of a video profile file is fairly simple but troubles arise when something goes wrong. Operating the Flash Media Live Encoder requires media technology expertise. The Flash application does not support desktop capturing and requires a separate application for it. The test experience of using a 3rd party desktop capture application was far from promising. The customized solution gave an impression of a patchwork instead of a proper tool. On the other hand, it still possesses all of the required components.

The observation setup of the customized solution was a delightful experience. It was quite the same as in case of Livestream – a private hosted website. No more can be required from the observation setup.

Still, the customized solution provides only a video stream with no complementary features, such as IM (except the CDN support for global coverage in the final version). It depends on the perspective if it is a positive characteristic or a limiting factor. Whatever the case, the customized solution stands simplified and bare in front of the other solutions.

5.5 Summary and Comparison of the Solutions

This section presents the overall results for the selected solutions. The pros and cons of each solution are analyzed in the light of the tests and the features and capabilities of the solutions according to the companies offering the solutions. The solutions are compared against each other qualitatively. This section combines the previously presented results as one and assesses how the solutions can be ranked among each other. The overall results are first introduced and the solutions are compared. Then, each of the solutions is individually assessed and analyzed.

All of the solutions had their own respective strengths and weaknesses because they were selected to represent different kinds of approaches for the remote observation tool for usability testing. The overall pros and cons are summarized in Table 12. No obvious results are listed explicitly for all of the solutions. For example, privacy is available for all of the solutions. The table contains the most notable pros and cons instead.

Table 12: The overall pros and cons of the solutions

	Pros	Cons

Morae	• Focus on usability testing (cursor highlighting, markers). • Storing and sharing sessions. • Integration with TechSmith analysis software.	• Poor video quality. • Only a native Windows application available. • Rather complex setup. • No guarantees on the video delivery (no CDN or similar).
Skype	• Available for everyone. • Excellent video and audio quality. • Cross-device and cross-platform. • Large P2P network.	• Risk of unintentional two-way communication. • 3rd party software required for saving the videos. • Requires software installation.
Livestream	• SaaS – flexible and interoperable. • Installable software available for further efficiency and more features. • Excellent video and audio quality. • CDN support. • Lots of complementary features available.	• Privacy and other premium features available only with funds.

Customized	• Easy setup for the observing party.	• Complex setup for the testing party, requires expertise to achieve quality. • Provides only a video stream with no complementary features (such as IM).

The two solutions meant for usability testing in particular, Morae and the customized solution, were the poorest of performers. They were the hardest to use and they delivered the worst video quality experienced in the tests. However, both of them are capable of being used in usability tests even though the video quality of Morae is below requirements.

The two other solutions, Skype and Livestream, are quite the opposite of each other. They both deliver a delightful observation experience but are yet made for completely different kinds of purposes. Where Livestream is specifically built for streaming media and Skype is for communication, both of them support the remote observation of events without larger drawbacks.

But why is there even a contest between these two since Skype is not meant for one-way streaming video? The answer is that Skype's popularity and availability for all kinds of users is too much to be disregarded. It is obvious that money can buy a perfect solution. But it is interesting how a popular free of charge service performs in a task it is technologically capable of handling. Skype was a positive surprise even though its weaknesses were accounted for in the very beginning.

All of the setups were relatively simple, if the 3rd party desktop capture application hassle is not accounted for. It is however crucial to success that the minds of the usability experts are not tied to the setup when they are supposed to be fixed on the actual usability tests. That is, the usability experts cannot accomplish their tasks effectively if their focus is fixed on technical troubles. The SaaS-based approach of Livestream clearly outranked the other solutions in this matter. For example, Morae would be instantly out of the question if a usability test would to be conducted with uncharted equipment. Or otherwise, the Livestream approach would allow conducting usability tests anywhere with a device connected to the Internet.

The guarantees of reliable global delivery of data are distributed between the solutions in a similar way to the video quality; Morae does not include any guarantees of the delivery and the customized solution will have CDN support only in the full version. Livestream and Skype do have the promise of reliable delivery by a CDN and a huge P2P network. Both the global delivery without the sacrifice of quality and the overall reliability of the quality are critical requirements for the tool. Breaks or lost connections in the observation process might interrupt the flow of the observer and leave important findings unfound.

Saving the sessions is a way to compensate for the potential interruptions (whatever the cause) in the observation process. Saving the sessions is also a critical requirement defined in Section 4.1.1. Skype was the only solution that did not have support for such a feature right in the program. The problem can be solved by using 3rd party desktop recording software. But as was the case with 3rd party desktop capturing software with the customized solution, another part added into the system multiplies the risk level. Thus the lack of recording functionality in Skype should not be underestimated.

The flexibility of the solutions in terms of different setups available is rather equal. Morae and Livestream support PiP whereas the Flash Media Live Encoder is capable of many things in the right hands. Separate video and audio mixers, hardware or software, can be always used to increase the different number of setups available. However, they also increase the complexity of the whole system. All of the solutions support the selection of video and audio source and none support multiple separate audio channels.

6 Conclusions and Future Development

This chapter discusses the research results and assesses the potential areas of future development. The overall suitability of video streaming for usability testing is handled first. Then, the performance of the most promising solutions is concluded and the best-performing solution is discussed. Finally, different areas for future studies are suggested.

6.1 Conclusions

Video streaming seems to suit live usability test observation very well. No findings were made that would deny the suitability of the technology to the task. Quite controversially, the flexibility of the usability testing process increases and the expenses decrease when the observation of the test sessions is no longer tied to a certain location. The streaming tool is a part of a much larger process of product development including the human-centered design process and should support the whole process as well as the direct needs of the actual usability test observation process.

However, there are certain factors that favor the live presence of the observers. The live interaction with the test personnel before, during and after the tests enables the participation of the observers and increases the synergies in the process. Also the immediate interaction with the test participants enables instant follow-ups of events left unclear for the observer. On the other hand, streaming the test sessions online increases the level of effort required to conduct a set of usability test sessions.

The streaming technology enables some additional benefits compared to mere on-site observation. Once the tests are being streamed the additional effort to add extra observers is minimal. The extra observers could be, for example, some stakeholders in the product development process. Moreover, sharing the session videos is also easy as they are already in the web or at least ready to be taken online. On the other hand, streaming itself is always a security risk, no matter how strong the measures are.

There is no single generic right solution available to implement the video streaming tool. However, in theory, such a tool was defined as a set of different requirements.

There is no need for a high quality media experience as long as the solution enables the observer to make the necessary observations during the test sessions. Rather than focusing on different technical parameters of video streaming, the optimal solution is required to support the goals of the usability testing process. In practice, it would mean features like the ability to save the videos of the sessions for future analysis, preventing any interruptions during the observation process and support for different kinds of usability test setups.

Four different solutions were tested in a real usability testing environment and no perfect solution was found. Nevertheless, there are various decent solutions available and the meaning of best depends on the definition. The different solutions are all capable of being used in usability testing, each one of them in a certain setting.

The evaluated usability testing application, Morae, would perform well in local usability testing. The video and streaming quality of Morae is not sufficient to be trusted upon if the only means of observation is the remote observation tool. Morae offers interoperability with the other usability related applications from the same provider and is an appropriate choice when a comprehensive interoperable digital usability testing solution is required.

The low budget instant messaging representative, Skype, suits the occasions where the test sessions are not required afterwards. The sessions can be recorded with 3rd party applications when using Skype. However, if the sessions are to be recorded Skype is not the optimal choice. Skype does offer excellent quality and features beyond video transmission but is primarily a communication application and might be challenging to transform into a solid streaming tool. Thus, Skype would be an excellent choice for quick-and-dirty usability testing.

The web service for live video, Livestream, is the most outstanding choice to claim the throne of the tool but has also a price tag of high value. Livestream fills all of the requirements and possesses many of the complementary features. The money required to use the premium version of the service is in any case too much for a common web developer. The operation behind the usability testing must be organized and professional before Livestream is a rational choice.

The fourth and final tested solution, the demo of a customized application, holds great potential for the full version. It has many drawbacks, like the lack of an integrated desktop capture feature, but it delivers everything that is necessary with help of some additional components. The full version might be a proper solution for many smaller players.

The research was done in order to obtain results for a tool for all kinds of parties conducting usability tests. A single usability test conductor considering the adoption of a remote observation tool should also assess how the requirements might change because of their unique perspective. Furthermore, the tests that were held for the most promising solutions only focused on observing website/software usability testing. If a party is focusing on, for instance, group interviews they might find the test results partly irrelevant. On the other hand, for an average party conducting various usability tests, the results should deliver a sufficient evaluation of the desirable characteristics of a remote observation tool and offer reliable assessments of the four different types of solutions.

6.2 Future Development

The thesis was an overall assessment of the domain of live remote observation of usability tests and there are many areas waiting for deeper research. Many of the questions that arose in the course of the study are left without a proper answer since the scope of a Master’s thesis does not cover but a fragment of a larger matter.

The live streaming could be examined and tested further with different kinds of usability test setups. The test setup used in the research of this thesis was only a simple example of a usability test setting. Since the remote observation tool should support different kind of setups, testing the remote observation with, e.g., field usability testing would bring larger perspective into the study.

Testing the streaming technology and different solutions with real intercontinental data transmission would also validate the results further. Since the tests were observed in a room next to the testing room, although via Internet instead of a local network, the actual global operability remains unproven in practice.

The quality of streaming video and audio is a whole different topic but should also be examined further in the context of usability testing. The critical conditions were set in this thesis but the optimization of video and audio quality would offer a vast field of possible future studies. Furthermore, the delivery of streaming media could be explored in the context of the remote usability test observation requirements.

The field of technology studies could be expanded even further by investigating the security issues related to the streaming of delicate information of usability tests. Also the security issues in the whole process of usability testing when using streaming media for observation should be assessed as a whole. The security of a system is as good as the security of the weakest link and hardcore security measures do not help if there are other security holes included in the process.

Also the business aspects related to remote usability test observation would offer a wide variety of possible future studies. The remote observation tool is, after all, an investment. The profitability and return on of such an investment would be the primary areas of interest. Moreover, marketing related business aspects would be an interesting area of research and assessment. A remote observation solution could be a tangible source of competitive advantage for some parties conducting usability tests.

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Appendix 1: Summary of the Results of the Solutions

	Morae	**Skype**	**Livestream**	**The Customized Application**
Critical requirements				
Video quality	Below requirements, 13p font not recognizable.	Excellent.	Excellent.	Sufficient.
Audio quality	Good.	Excellent.	Excellent.	Good.
The smooth streaming flow	No guarantees.	A large P2P network.	CDN.	CDN.
Test site setup complexity	Installation and Windows OS required.	Installation required, a user account required.	SaaS.	Installation, profile file (or expertise) and possibly a desktop capture application required.
Observation site setup complexity	Transmitter's IP address required in addition to the above.	Installation required, a user account required.	SaaS.	SaaS.

The management of the system	By TechSmith.	No hosting available.	SaaS.	SaaS.
Support for video sources	Supported.	Supported.	Supported.	Supported, no built-in desktop capture.
Support for audio sources	Supported.	Supported.	Supported.	Supported.
Saving the test session videos	Supported, locally or to TechSmith service.	No built-in support.	Supported, SaaS.	Supported, SaaS.
Security	Yes, VPN option.	Yes, 256-bit Rijndael encryption.	Yes, privacy as a premium service.	Yes, SSL encryption.
Complementary features				
Multiple simultaneous video channels	PiP.	Yes, by using multiple computers with group video chat.	PiP.	No built-in support for PiP or similar.
A second separate audio channel	No.	No.	No.	No.

Reliable global coverage	No.	Large global P2P network.	CDN support.	CDN support.
Remote camera control	No.	No.	No.	No.
Interaction	No.	Yes, IM & calling & video chat.	Yes, IM.	No.
VCR capabilities	No.	No.	No.	No.
Live editing	No.	Yes.	Yes.	No.
High definition	No.	Yes.	Yes.	No.
(3D video technology)	(No).	(No).	(No).	(No).